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'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

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Animal Physiology.

BY ARTHUR NEWSHOLME, M.D., AND C.S.S. (LOND.)

THE NERVOUS SYSTEM.

THE digestive, secretory, circulatory, and excretory functions, which have been discussed in previous chapters, are chiefly carried on without the conscious intervention of the individual.

In the nervous system we have a most elaborate mechanism for carrying impulses to and from every part of the body, and from the outer world, and for the conscious interpretation of these. The nervous and muscular systems are the great master systems of the animal system, and the other organs may be regarded simply as servants supplying their wants. But even the muscles of the body are helpless in the absence of the nervous impulses which cause and co-ordinate their movements. Thus the nervous system is the chief and controlling part of the organism, and in highly organised animals any derangement of it is immediately followed by disorder of the more lowly organs.

The nervous system is divided into two great parts:

1. The *cerebro-spinal system*, composed of the brain and spinal cord, and the nerves connected with them. A general view of this system is shown in Fig. 59.

2. The *sympathetic*, or organic system, which is chiefly concerned with the nutritive functions, and is the only representative of the nervous system present in invertebrate animals.

There are two chief kinds of nervous impulses, *motor* and *sensory*. For the performance of movement, three things are necessary, a central organ from which the nervous stimulus starts, a nerve along which this stimulus is carried, and a muscle which contracts when this stimulus is communicated to it.

Similarly for the reception of a sensation, three things are necessary, a sensory peripheral organ which receives the stimulus, a nerve along which this is carried, and a central organ receiving and interpreting the stimulus. The nerves carrying impulses from the periphery to the central organ are called *centripetal* or *afferent*, and they are *sensory* in functions; those carrying impulses in the opposite direction are called *centrifugal or efferent*, and are chiefly *motor* in function.

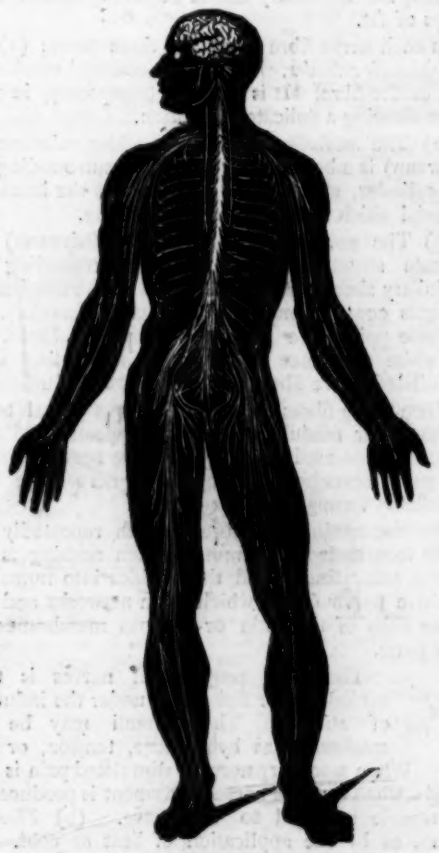

Fig. 59.
General view of the Cerebro-Spinal System.

The peripheral organs from which nervous impulses may be received are numerous. They are enumerated

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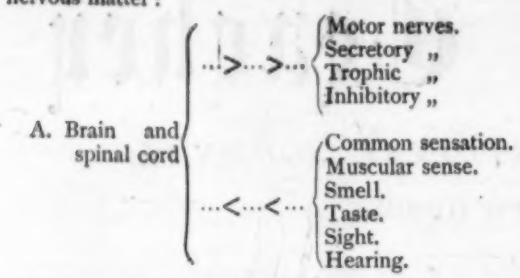
in the following scheme of the nervous system, which shows the general relationship of the various kinds of nervous matter:



B. Sympathetic or organic system.

Nerves are the carriers of stimuli between the central nervous organs and the periphery. Each nerve consists of a number of bundles of nerve-fibres, held together by connective tissue, in which are contained blood and lymphatic vessels and fat-cells.

The ultimate nerve-fibres in cerebro-spinal nerves are doubly contoured smooth cylindrical fibres, varying between $\frac{1}{2000}$ and $\frac{1}{12000}$ inch in diameter. The fibre in the fresh condition appears as a bright glistening cylinder; but after death the interior becomes irregular, the medullary matter becoming detached like drops of fat.

In each nerve fibre there are three parts: (1) the *central axis-cylinder*, which is the essential conducting part of the fibre. It is pale and transparent, in some cases showing a delicate fibrillation.

(2) The *medullary sheath* (or white substance of Schwann) is a bright fatty substance surrounding the axis-cylinder, and may be compared to the insulating material which surrounds an electric wire.

(3) The *neurilemma* (or sheath of Schwann) is a delicate structureless membrane, surrounding the medullary sheath. At certain intervals the neurilemma presents constrictions (called nodes of Ranvier), and at these points the medullary sheath is absent. In the white substance of the brain and spinal cord, medullated nerve fibres occur without any neurilemma.

When nerve fibres approach their peripheral terminations their medullary sheath disappears, and then we have a non-medullated fibre. The nerves of smell and most branches of sympathetic nerves are non-medullated throughout their course.

The non-medullated fibres branch repeatedly and finally lose their neurilemma. Then nothing is left but the axis-cylinder, and this divides into numerous primitive nerve fibrils, which form networks and end in the cells of the skin or mucous membranes, or other parts.

Properties of Nerves.

The chief property of nerves is their excitability or irritability under the influence of *stimuli*. The stimuli may be (a) *mechanical*, as by pressure, tension, or section. When a sensory nerve is stimulated pain is produced; when a motor nerve, movement is produced in the muscle attached to the nerve. (b) *Thermal* stimuli, as by the application of heat or cold. (c) *Chemical* stimuli. (d) *Physiological*, or normal stimuli, which are either centifugal, centripetal, or reflex.

(e) *Electrical stimuli*, which act most powerfully at the moment the current is applied, and at the moment when it ceases.

Nerve-fibres possess no power of initiating currents of their own accord. They require stimulating by one of the previously enumerated agents; in other words they serve as mere conductors of impressions. The rate at which impulses travel along motor nerves has been estimated at 111 feet per second, and along sensory nerves at 140 feet per second.

When a sensory nerve is divided, and irritation is applied to the portion connected with the nervous centre, sensation is perceived in the parts to which the nerve is distributed; but if the distal portion of the divided nerve is irritated, no effect appears. But if a motor nerve is divided, and the central part irritated, no effect is produced; while if the peripheral part is irritated, movement is produced in the muscles to which the motor nerve is distributed.

Nerve Endings.

Nerves end at one extremity in the nerve centres (brain, spinal cord), at the opposite extremity in certain peripheral end organs.

Nerves of common sensation either end by their axis-cylinder splitting into minute fibrillæ, which become connected with epithelial cells; or as special terminal organs, *e.g.*, Pacinian corpuscles, end bulbs, and tactile corpuscles.

Pacinian corpuscles occur largely in the hand and foot of man and in other parts. Each corpuscle is oval, never exceeding $\frac{1}{10}$ inch in length. It consists of a large number of capsules or lamellæ, arranged around a central elongated space, which contains a prolongation of the axis-cylinder of the nerve-fibre.

End bulbs are minute corpuscles, each containing a minute nerve fibre. *Tactile corpuscles* occur in the papillæ of the skin. In man they are about $\frac{1}{300}$ inch long. Each contains a nerve-fibre, which usually first winds round the corpuscle once or twice, and then penetrates its interior.

Motor nerves going to striped muscle, end in what is known as a *motor-end plate*. The neurilemma becomes fused with the sarcolemma, and the axis cylinder splits into a number of fibrils which become embedded into this plate.

The mode of termination of sympathetic nerves in unstriped muscular tissue is by the axis-cylinder splitting into a number of fibrils which from a plexus, from which branches run to the individual muscle cells. The nerves of blood-vessels terminate in the muscular coat of the vessels in a similar manner.

(To be continued.)

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Easy Steps in Trigonometry.

BY REV. A. D. CAPEL, M.A.,

Author of 'Catch Questions in Arithmetic,' etc., etc.

ANSWERS AND HINTS TO SOLUTIONS.

CHAPTER XVI.

1. $\sin 15 = \frac{1}{2}(\sqrt{1+\frac{1}{2}} - \sqrt{1-\frac{1}{2}})$.

2. $\cos 70 = \frac{1}{2}(\sqrt{1+\sin 140^\circ} - \sqrt{1-\sin 140^\circ})$.

3. $\cos 235 = \frac{1}{2}(-\sqrt{1+\cos 470} + \sqrt{1-\cos 470})$.

4. $\sin 133\frac{1}{2} = \frac{1}{2}(\sqrt{1+\sin 267} + \sqrt{1-\sin 267})$.

5. $\text{Cos } 212\frac{1}{2} = \frac{1}{2}(-\sqrt{1+\sin 424\frac{1}{2}} - \sqrt{1-\sin 424\frac{1}{2}})$.

6. $\text{Cos } 310 = \frac{1}{2}(-\sqrt{1+\sin 260} + \sqrt{1-\sin 260})$.

7. $\text{Sin}(-4) = \frac{1}{2}(\sqrt{1+\sin(-8)} - \sqrt{1-\sin(-8)})$.

8. $\text{Cos}(-130) = \frac{1}{2}(-\sqrt{1+\sin(-260)} + \sqrt{1-\sin(-260)})$

9. $\text{Cos } 130 = \frac{1}{2}(\sqrt{1+\sin 260} - \sqrt{1-\sin 260})$.

10. $\text{Sin } 20 = \frac{1}{2}[\sqrt{1+\sin 40} - \sqrt{1-\sin 40}] = \frac{1}{2}a$, say

$$\sin 10 = \tfrac{1}{4}[\sqrt{1+\tfrac{1}{2}a} - \sqrt{1-\tfrac{1}{2}a}]$$

11. $\text{Cos } 18 = \frac{1}{2}[\sqrt{1+\sin 36} + \sqrt{1-\sin 36}] = \frac{1}{2}b$, say

$$\sin 18 = \sqrt{1-\frac{b^2}{4}}$$

$$\cos 9 = \tfrac{1}{2}\left[\sqrt{1+\sqrt{1-\frac{b^2}{4}}} + \sqrt{1-\sqrt{1-\frac{b^2}{4}}}\right]$$

12. $\text{Cos } 8 = \frac{1}{2}[\sqrt{1+\sin 16} + \sqrt{1-\sin 16}] = \frac{1}{2}c$, say

$$\sin 8 = \sqrt{1-\frac{c^2}{4}}$$

$$\therefore \sin 4 = \tfrac{1}{2}\left[\sqrt{1+\sqrt{1-\frac{c^2}{4}}} - \sqrt{1-\sqrt{1-\frac{c^2}{4}}}\right] = \tfrac{1}{2}d, \text{ say}$$

$$\cos 2 = \tfrac{1}{2}\left[\sqrt{1+\frac{d^2}{4}} + \sqrt{1-\frac{d^2}{4}}\right]$$

13. $\text{Cos } 195° = \frac{1}{2}[-\sqrt{1+\sin 390°} - \sqrt{1-\sin 390°}]$

$= \frac{1}{2}[-\sqrt{1+\frac{1}{2}} - \sqrt{1-\frac{1}{2}}]$

$= -\frac{1}{2}[\sqrt{\frac{3}{2}} + \sqrt{\frac{1}{2}}]$

$= -\frac{1}{4}[\sqrt{6} + \sqrt{2}]$

which could be calculated.

14. $\text{Sin } 45° = \frac{1}{2}[\sqrt{1+1} - \sqrt{1-1}]$

$= \frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$

$$\sin 22\tfrac{1}{2} = \tfrac{1}{2}\left[\sqrt{1+\frac{1}{\sqrt{2}}} - \sqrt{1-\frac{1}{\sqrt{2}}}\right]$$

which could be reduced to

$$\tfrac{1}{2}\left[\sqrt{\frac{2+\sqrt{2}}{2}} - \sqrt{\frac{2-\sqrt{2}}{2}}\right]$$

$$\text{or } \tfrac{1}{4}[\sqrt{4+2\sqrt{2}} - \sqrt{4-2\sqrt{2}}]$$

15. Expand cos (2A + A) by Form. 12. Apply Formulas 9 (not 7), 6, and 1.

16. $4\cos^3 30 - 3\cos 30 = 0$

$\therefore 4\cos^2 30 - 3 = 0$

$\therefore \cos 30 = \pm\frac{\sqrt{3}}{2}$

17. $\text{Cos } 30 = \sqrt{\frac{1+\cos 60}{2}}$

18. $\text{Sin } 210 = -\sqrt{\frac{1-\cos 60}{2}}$

19. $\text{Sin } 50 = \sqrt{\frac{1-\cos 260}{2}}$

20. $\text{Cos } 40 = \sqrt{\frac{1+\cos 280}{2}}$

21. $2\sin 18\cos 18 = 4\cos^3 18 - 3\cos 18$

$\div \cos 18$; $2\sin 18 = 4\cos^2 18 - 3$

$= 4(1-\sin^2 18) - 3$

$4\sin^2 18 + 2\sin 18 - 1 = 0$

$$\therefore \sin 18 = \frac{-1 \pm \sqrt{5}}{4}$$

Since sin 18 is positive we must take the upper sign

$$\therefore \sin 18 = \frac{\sqrt{5}-1}{4}$$

$$\cos 18 = \sqrt{1-\frac{6-2\sqrt{5}}{16}} = \tfrac{1}{4}\sqrt{10+2\sqrt{5}}$$

22. $\text{Sin } 9° = \sqrt{\frac{1-\cos 18}{2}}$

$$= \sqrt{\frac{1-\frac{\sqrt{10+2\sqrt{5}}}{4}}{2}} = \tfrac{1}{4}\sqrt{4-\sqrt{10+2\sqrt{5}}}$$

23. $\text{Cos } 4°\,30' = \frac{1}{2}\left[\sqrt{1+\frac{1}{2}\sqrt{\frac{4-\sqrt{10+2\sqrt{5}}}{2}}} + \sqrt{1-\frac{1}{2}\sqrt{\frac{4-\sqrt{10+2\sqrt{5}}}{2}}}\right]$

24. $\text{Sin } 30° = \frac{1}{2}$

$\text{sin } 15° = \frac{1}{2}[\sqrt{1+\frac{1}{2}} - \sqrt{1-\frac{1}{2}}]$

$= \frac{1}{2\sqrt{2}}(\sqrt{3}-1)$

$$\sin 7°\,30' = \tfrac{1}{2}\left[\sqrt{1+\frac{1}{2\sqrt{2}}(\sqrt{3}+1)} + \sqrt{1-\frac{1}{2\sqrt{2}}(\sqrt{3}-1)}\right]$$

25. $\text{Sin } 12° = \sin(30-18)$

$= \sin 30\cos 18 - \cos 30\sin 18$

$= \frac{1}{2}\cdot\frac{1}{4}\sqrt{10+2\sqrt{5}} - \frac{\sqrt{3}}{2}\cdot\frac{\sqrt{5}-1}{4}$

$= \frac{1}{8}[\sqrt{10+2\sqrt{5}} - \sqrt{15} + \sqrt{3}]$

CHAPTER XVII.

1. The student is recommended to draw a right angled triangle in all cases, and put the values given against the two of the sides designated by the ratio expressed, and find that of the third by Euc. I. 47, *e.g.*, in 1 the perpendicular will be a, the hypotenuse 1 and $\therefore$ the base $\sqrt{1-a^2}$ and hence the tan $\frac{a}{\sqrt{1-a^2}}$

2. $\frac{1}{b}$.

3. $\sqrt{1-c^2}$.

4. $\frac{\sqrt{3}}{2}$.

5. $ab + \sqrt{1-a^2}\sqrt{1-b^2}$.

6. $\frac{a+b}{1-ab}$.

7. $\dfrac{\frac{a}{\sqrt{1-2a^2}} + b}{1 - \frac{ab}{\sqrt{1-2a^2}}}$ or $\dfrac{a+b\sqrt{1-2a^2}}{\sqrt{1-2a^2}-ab}$

8. $\sqrt{1-a^2}\cdot\frac{1}{\sqrt{1+a^2}} - a\cdot\frac{a}{\sqrt{1+a^2}}$ or $\dfrac{\sqrt{1-a^2}-a^2}{\sqrt{1+a^2}}$.

9. $\frac{1}{2}\cdot\frac{1}{2} + \frac{\sqrt{3}}{2}\cdot\frac{2\sqrt{2}}{3} = \frac{1+2\sqrt{6}}{6}$

10. $\tan\cos^{-1}\frac{1}{\sqrt{1+a^2}} = a$ and $\sec\sin^{-1}a = \frac{1}{\sqrt{1-a^2}}$

11. $\text{Sin}\,[\text{cosec}^{-1}\sqrt{50} + \text{cosec}^{-1}\sqrt{65}] = \frac{1}{\sqrt{50}}\cdot\frac{8}{\sqrt{65}} + \frac{7}{\sqrt{50}}\cdot\frac{1}{\sqrt{65}}$

$$= \frac{15}{5\sqrt{10\times 13}} = \frac{3}{\sqrt{130}}$$

$$\therefore \text{cosec}^{-1}\sqrt{50} + \text{cosec}^{-1}\sqrt{65} = \sin^{-1}\frac{3}{\sqrt{130}}$$

12. $\frac{\frac{1}{3}+\frac{1}{3}}{1-\frac{1}{3}\cdot\frac{1}{3}} = \frac{6}{14}$ or $\frac{3}{7}$

13. $\frac{\frac{3}{5}+\frac{1}{7}}{1-\frac{3}{5}\cdot\frac{1}{7}} = \frac{5\times 7}{45}$ or $\frac{7}{9}$

14. $\frac{\frac{1}{2}+\frac{1}{3}}{1-\frac{1}{2}\cdot\frac{1}{3}}$ or $\frac{5}{5}$ or 1.

but $\tan^{-1} 1 = 45°$.

15. $\text{Tan}\,(\tan^{-1}\frac{1}{2} + \tan^{-1}\frac{1}{3}) = \frac{\frac{1}{2}+\frac{1}{3}}{1-\frac{1}{2}\cdot\frac{1}{3}} = \frac{5}{5} = \frac{3}{11}$

$$\therefore \tan^{-1}\tfrac{1}{2} + \tan^{-1}\tfrac{1}{3} = \tan^{-1}\tfrac{3}{11}$$

again $\tan\,(\tan^{-1}\frac{1}{5} + \tan^{-1}\frac{3}{11}) = \frac{\frac{1}{5}+\frac{3}{11}}{1-\frac{1}{5}\cdot\frac{3}{11}} = \frac{26}{52} = \frac{1}{2}$

$$\therefore \tan^{-1}\tfrac{1}{5} + \tan^{-1}\tfrac{3}{11} = \tan^{-1}\tfrac{1}{2}$$

Lastly $\tan\,(\tan^{-1}\frac{1}{2} + \tan^{-1}\frac{1}{3}) = \frac{\frac{1}{2}+\frac{1}{3}}{1-\frac{1}{2}\cdot\frac{1}{3}} = \frac{5}{5} = 1$

$$\therefore \tan^{-1}\tfrac{1}{2} + \tan^{-1}\tfrac{1}{3} = \tan^{-1} 1 = 45°$$

$$\therefore \tan^{-1}\tfrac{1}{2} + \tan^{-1}\tfrac{1}{5} + \tan^{-1}\tfrac{1}{7} + \tan^{-1}\tfrac{1}{8} = 45°.$$

16. To prove this we can remove one of the terms from the L.H.M. to the R.H.M. of the equation thus

$$\cos^{-1}\tfrac{3}{4} + \cos^{-1}\tfrac{5}{13} = \pi - \cos^{-1}\tfrac{1}{2}$$

If $\cos\,(\cos^{-1}\frac{3}{4} + \cos^{-1}\frac{5}{13}) = -\cos\,(\cos^{-1}\frac{1}{2})$

$$\text{If } \tfrac{3}{4}\cdot\tfrac{5}{13} - \frac{\sqrt{7}}{4}\cdot\frac{5\sqrt{7}}{16} = -\tfrac{1}{2}$$

$$\text{If } -\tfrac{1}{2} = -\tfrac{1}{2}.$$

17. $\text{Tan}\,(\cot^{-1}\frac{1}{2} + \cot^{-1}\frac{1}{3}) = \frac{2+3}{1-6}$ or -1

$$\tan\left(\tan^{-1}(-1) - \cot^{-1}\frac{1}{2+\sqrt{3}}\right) = \frac{-1-2-\sqrt{3}}{1-2-\sqrt{3}}$$

$$= \frac{-\sqrt{3}(\sqrt{3}+1)}{-(\sqrt{3}+1)} = \sqrt{3} = \tan^{-1}\frac{\pi}{3}$$

18. $\text{Tan}\,2\tan^{-1}\frac{1}{3} = \frac{\frac{2}{3}}{1-\frac{1}{9}} = \frac{6}{8} = \frac{3}{4}$

$$\tan\,(\tan^{-1}\tfrac{3}{4} + \tan^{-1}\tfrac{1}{7}) = \frac{\frac{3}{4}+\frac{1}{7}}{1-\frac{3}{4}\cdot\frac{1}{7}} = \frac{25}{25} = 1$$

$$= \tan^{-1}\frac{\pi}{4}$$

19. $\text{Tan}\,2\tan^{-1}\frac{1}{5} = \frac{\frac{2}{5}}{1-\frac{1}{25}} = \frac{5}{12}$

$$\tan\,2\tan^{-1}\tfrac{1}{3} = \frac{\frac{2}{3}}{1-\frac{1}{9}} = \frac{3}{4}$$

$$\tan\,(\tan^{-1}\tfrac{1}{7} + \tan^{-1}\tfrac{3}{4}) = \frac{\frac{1}{7}+\frac{3}{4}}{1-\frac{1}{7}\cdot\frac{3}{4}} = \frac{25}{25} = 1$$

$$\tan\,(\tan^{-1}\tfrac{25}{72} + \tan^{-1}\tfrac{1}{8}) = \frac{\frac{25}{72}+\frac{1}{8}}{1-\frac{25}{72}\cdot\frac{1}{8}} = 1$$

$$= \tan^{-1}\frac{\pi}{4}$$

20. $\text{Tan}\,2\tan^{-1}\frac{1}{5} = \frac{5}{12}$

$$\tan 2\tan^{-1}\tfrac{5}{12} = \frac{\frac{10}{12}}{1-\frac{25}{144}} = \frac{120}{119}$$

$$\therefore \tan 4\tan^{-1}\tfrac{1}{5} = \tfrac{120}{119}$$

$$\tan\,(\tan^{-1}\tfrac{120}{119} - \tan^{-1}\tfrac{1}{70})$$

$$= \frac{\frac{120}{119}-\frac{1}{70}}{1+\frac{120}{119}\cdot\frac{1}{70}} = \frac{8281}{8449}.$$

$$\tan\,(\tan^{-1}\tfrac{8281}{8450} + \tan^{-1}\tfrac{1}{99}) = \frac{\frac{8281}{8450}+\frac{1}{99}}{1-\frac{8281}{8450}\cdot\frac{1}{99}} = 1 \text{ \&c.}$$

21. $\text{Sin}\,3\sin^{-1} a = 3a - 4a^3 \quad \therefore$ \&c.

22. $\text{Tan}\,[\sin^{-1}(\cos x) + \cos^{-1}(\sin y)]$

$$= \frac{\frac{\cos x}{\sin x}+\frac{\cos y}{\sin y}}{1-\frac{\cos x}{\sin x}\cdot\frac{\cos y}{\sin y}} = -\frac{\sin(x+y)}{\cos(x+y)}$$

$$= -\tan(x+y)$$

$$\therefore \sin^{-1}(\cos x) + \cos^{-1}(\sin y) = \tan^{-1}[-\tan(x+y)]$$

$$= -x-y.$$

$$\text{and } -x-y+x+y = 0 = \tan^{-1}\pi.$$

23. Taking the tangents of either side

$$\frac{3x-x}{1+3x^2} = \frac{1}{2}$$

$$\therefore x = \tfrac{1}{3} \text{ or } 1.$$

24. Taking the sines of either side

$$\frac{\sqrt{x^2-a^2}}{x}\cdot\frac{b}{x} - \frac{\sqrt{x^2-b^2}}{x}\cdot\frac{a}{x} = \frac{\sqrt{b^2-1}}{b}\cdot\frac{1}{a} - \frac{\sqrt{a^2-1}}{a}\cdot\frac{1}{b}$$

In which we see that if we write a^2b^2 for x^2 the equality will be satisfied.

25. Take the tangents of either side

$$\frac{2x+3x}{1-6x^2} = 1 \quad \therefore x = \tfrac{1}{6} \text{ or } -1.$$

(To be continued.)

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Prize Essay on the Best Method of Teaching Geography in Elementary Schools.

Awarded by the Scottish Geographical Society.

BY A. POLSON,

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THE pupils should next by means of a large map of the world, and a globe on which the markings are very distinct be got to master the chief physical features of the continents, *not* those of each of the particular countries into which they are divided. Having obtained this general view of the world, the stage of geographical teaching hardest, but certainly most interesting, is entered on—hardest because it necessitates much reading and thought on the part of the teacher, and interesting because of its usefulness, and the amount of novel information conveyed to the class by a teacher who is always on the outlook for interesting matter by which he may illustrate his lessons.

In geography after the initiatory stages have been passed the teacher is bound by no philosophical sequence in the selection of the particular facts he is

to teach; and generally speaking, the particular geography which is of great interest this year, *e.g.*, that of Egypt and the south east of Europe, may next year be of no more interest than that of Brazil is at present, and therefore the teacher should for the sake of his pupils teach what experience points out as being of most permanent interest. In the lessons at this stage it must be borne in mind—and at this stage it seems oftenest forgotten—that it is still quite as important as it was at the earlier stages that 'instruction is to be given in the new by rooting it in the old so that it may grow out of it organically' and that 'all knowledge as it is acquired should be turned to use.'

It is almost needless to say that to the great majority of the pupils the geographical knowledge which will be most often needed is that of their own country, then that of our colonial possessions, and lastly that of other particular countries. The teacher should therefore again begin with (*a*) our own country, and the knowledge already obtained of its physical features, towns, and political divisions should be revised and considerably amplified. In addition, however, they should know what geographical reasons there are for the greatness of Britain, 'this precious stone set in the silver sea.' They should understand how it is that though we are situated quite as far north as either Labrador or Moscow, we have an excellent equable temperature as compared with them, enabling people, as Charles II. said, to work on a greater number of days per year than in any other country in the world. They should know that it is the physical aspect and position of the country which have certainly to some extent conduced to that love of liberty which is characteristic of the inhabitants of Britain—Scotland and Wales being mountainous, and it always is a characteristic of the inhabitants of mountainous countries to love liberty, while the insular position of the whole country has accentuated this trait, for it is true, as Wordsworth says, that:—

> 'Two voices are there, one is of the sea,
> One of the mountains, each a mighty voice;
> In both from age to age thou didst rejoice,
> They were thy chosen music, Liberty.'

In considering the industries, it should be pointed out that is a manufacturing country because nature has abundantly supplied the means—minerals—so necessary for the carrying on of manufactures, and that 'The possession of these minerals is the basis on which rest the manufacturing industry of our Manchesters, Birminghams, Sheffields, and Glasgows. Then the children are led to consider how the results of this industry are disposed of; the necessity of an outlet and the character of the sea-board of the country are the considerations which explain the extent of its commercial engagements, and the wealth and population of our Londons, Liverpools, Bristols, Hulls, Glasgows, and Dundees. These commercial cities are not the growth of accident any more than those already mentioned, but have become what they are under the influence of clearly discernable causes. Finally, the conditions of this industry are partly dependent on materials obtained from abroad, such as cotton, whilst the result of it must bring to us in exchange those commodities which we need, but do not find at home, chiefly articles of food and luxury as tea, sugar, and wine. Thus the importance of our seaports as outlets is enhanced by their importance as inlets. By geographical study pursued in this way, all the departments of our industrial life are understood in their organic connection, and also the mutual dependence of all the departments of the industry of man.'

(*b*) In teaching the geography of our colonial possessions, the teacher should have before the class a large map of the world, on which each of them is distinctly marked—say by being coloured red—and side by side with such a map should hang a map of the colony under consideration if the school furniture comprises such, if not, the teacher should be able to sketch it roughly on the blackboard. By these means the colony's relation to the countries around is seen at a glance. The pupils should then, by means of their books and some explanations, &c., by the teacher, know its physical aspect and its climate especially, its produce, industries, imports and exports, its political relation to the mother country, with some account of its desirableness as a field for emigration. It would add to the interest of the lesson if the manner of our coming into possession of these lands so distant from the mother country were pointed out. When the colonies have been gone over *seriatim* in this style, it should be evident to the pupils that we still hold each of our colonies because many of the inhabitants are our kith and our kin, and wish to be connected with the mother country by all possible ties; and being so, they help us by doing as much of their business as possible in our markets, sending their raw produce to the manufacturing mother country, to be sent from thence in a manufactured state to all parts of the world, and in return accepting our manufactured goods. They help us also in our wars, and we do the same for them in theirs, of which the most recent example is the help sent by Australians and Indians to our soldiers in the Soudân.

Although it may be done at an earlier stage, it is certain that at this and the following stages it gives a more living interest to the geography lesson, besides forming an excellent revisal exercise, occasionally to go over the list of sailings in a daily paper and say what probable cargoes the vessels therein mentioned bring with them to and from their destinations.

(*c*) In teaching the geography of foreign countries it is best first to get the children to master the outstanding facts in the country's physical and political geography, using a map of the continent as well as of the country, and having a globe at hand for reference and then proceeding by methods similar to those already described. It should, as was done in the case of the home country and the colonies, be shown how the physical aspect of the country affects its productions, and hence its commerce, and the character of the people who inhabit it; for example in teaching the geography of Holland it is easy to get the children—now probably fourteen years or over—to understand that being a flat and moist country it is much more suitable for grazing purposes than for the growth of cereals, and hence that the people are engaged in, and indeed have long been celebrated for, the manufacture of butter and cheese, and that it is perhaps because the sea is kept out by immense 'dykes' which need to be constantly watched, and carefully kept in repair, that its people are habitually so far-seeing and

industrious. Besides pointing out similar traits in the character of the Belgians, the reasons of its being 'the battlefield of modern Europe' should be indicated. In getting up the geography of France it should be made evident that here, combined with a genial climate is a kindly soil which yields an abundance when well cultivated, and that the people seeing this have become so industrious that by their industry, combined with their thrifty habits, they were in a very short time able to recover their country from the effects of a great national calamity. It would also certainly be highly interesting to show what effect their geographical surroundings have on the keeping alive of their intense military ardour. On the other hand, it is easy to show when dealing with the geography of such countries as are for the most part composed of vast and rich plains, that an abundance being yielded to the inhabitants with very little exertion on their part, they are in consequence lazy, non-migratory, easily conquered by an active foreign power, and withal slow to adopt any means which might be helpful in securing to them a forward rank among the nations.

When the pupils have gone over each of the countries of the globe in this way the amount of thoroughly useful geographical knowledge which they will then have acquired is probably as much as can be expected in the present condition of our elementary schools. In conclusion it may be said that considering the importance of this subject of geography and the necessity of teaching it well, it would be advisable that of the two sets of reading books which 'My Lords' say are necessary in each of the standards of our elementary schools, one, at least, should be a set of geographical readers.

Knitting Maps.

BY MRS. J. D. HARRIS.

GENTLEMAN'S SOCK.

PINS 16, 5 oz. Fingering.

Cast on 32 stitches on each pin, 96 in all.

Knit 2, purl 2 for 3 inches.

A. Knit 16, take up seam-stitch. This is the back pin.

To reduce for calf of leg.

B. Knit 13, knit 2 together, knit 1, seam 1, knit 1, slip 1, knit 1, pick slip stitch over.
Knit 6 rounds between each reducing.

C. 85 stitches. Knit plain 5½ inches.

Rules for Heel.

D. On the back pin put 21 stitches each side of seam stitch, 21 on each instep pin

E. Knit and purl the alternate rows of back pin, slipping the 1st stitch of each row, till you have 18 loops on each side

F. Purl 26, take 2 together, turn the pin.
Knit 10, knit 2 together, turn the pin.
Purl 10, knit 2 together, repeat till all the stitches are taken up.

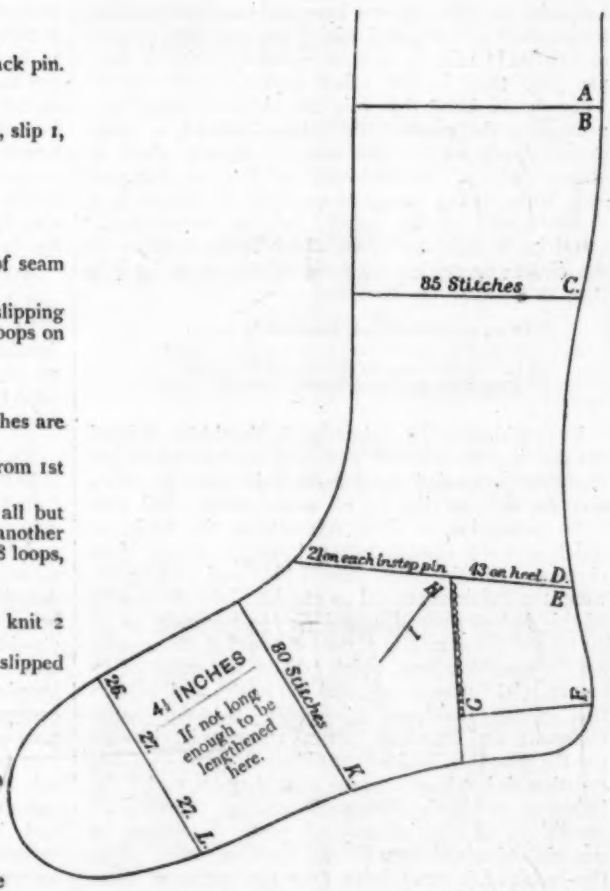
G. 1st heel-pin. Take up 18 loops, and knit 4 from 1st instep-pin.

H. Knit the remaining instep stitches on 1 pin, all but the 4 last of the second pin, knit these on another pin which is now the *2nd heel-pin*, take up 18 loops, and knit 6 from 1st heel-pin.
Knit 1 plain round.

I. 1st heel-pin, Knit to within 6 of the end, knit 2 together.
2nd heel-pin, Knit 4, slip 1, knit 1, pick slipped stitch over.
Knit 1 plain round between each reducing.

K. Reduce to 80 stitches.

L. 27 on each back pin, 26 on front.
1st back pin. Knit 2, knit 2 together, at 4 from the end of pin, knit 2 together.
2nd pin, repeat.
3rd pin, repeat.
Knit 3 plain rounds.
Repeat till the stitches are reduced to 25, divide on 2 pins, knit together and cast off.



(To be continued.)

PARTING SONG.

Moderato.
mf
1st TREBLE.
2nd TREBLE.
BASS.
Once be-fore we part We'll raise the joy-ful cho-rus, And with cheer-ful
While the wave-lets' band, A-cross the swell-ing o-cean, On-ward to the
KEY F. Moderato.
mf
heart, The fu-ture view be-fore us. Joy-ous were the hours That
strand, Roll on with gen-tle mo-tion. Thus rolls mu-sic's strain, Re-
C.t.
f.F.
we with song have pass'd; Mu-sic twines sweet flow'rs Whose o-dours ev-er
fresh-ing life's dull shore; Sooth-ing grief and pain, Till sor-row's reign is
p
p
last, Mu-sic twines sweet flow'rs Whose o-dours ev-er last.
o'er, Sooth-ing grief and pain, Till sor-row's reign is o'er.

Mental Arithmetic, its Principles and Practice.

BY REV. A. D. CAPEL, M.A.,

Author of 'Catch Questions in Arithmetic,' 'Tips in Algebra,' 'Easy Steps in Trigonometry,' etc., etc.

INTRODUCTION.

1. My wish in these papers is not only to give the rules by which mental calculations of numbers and quantities may be made, but the principles on which these rules are formed.

2. My experience is that a rule without a reason is a piece of knowledge, if worthy of the name, that nothing but incessant practice can retain in the memory.

3. Again I fully believe the cultivation of memory pure and simple, *e.g.*, of propositions of Euclid, lines of poetry, and even rules in grammar, is always done at the cost of the reasoning faculties.

4. No rule will therefore be given in this series of papers, that is not fully explained.

5. These papers being specially prepared for Pupil Teachers, who are examined in this subject on paper, and not orally, we shall always take this fact into consideration.

6. To answer mental questions with the pen rather than the mouth, is not quite the same thing, *e.g.*, if asked to multiply say 347 by 37, we should not adopt quite the same method if we had to say the answer, as we should if we had to write it. In the latter case we should write the figures as we found them from right to left, whereas in the other case, even if we found the units first, which we should have to retain in our memory whilst finding the others, we should have to mention the higher denominations first.

7. We will work the example mentioned in 6 both ways; and first let us do it as we should if we were going to write it down: the units we see at once must be 9; the tens must be 4 (carried) + 8 (the units of 28) + 1 (the units of 21) or 3 (with 1 to carry); the hundreds are 1 + 2 + 2 (carried) + 1 (units of 21) + 2 (units of 12) or 8, and the thousands are 1 + 2 (carried) + 9, or 12: hence our numbers will have been gradually built up from the right hand to this, viz., 12,839.

To do this when we were expected to speak our answer, we should probably begin at the other end thus: $300 \times 30 = 9{,}000$, and $40 \times 30 = 1{,}200$, and $300 \times 7 = 2{,}100$, whence we get 12,000 and 3 hundreds (to carry); again $40 \times 7 = 280$ and $7 \times 30 = 210$, hence our hundreds are 3 (carried) + 2 + 2 + 1 (from the tens) or 8; with 8 + 1 + 4 (from the 49) tens, ten of which have been included with the hundreds, concluding with 9, hence we can say 12 thousand 8 hundred and 39, instead of writing down 9, 3, 8, and 12 from the right hand.

CHAPTER I.

ADDITION AND SUBTRACTION, MULTIPLICATION AND DIVISION, AND INVOLUTION AND EVOLUTION, WITH SMALL NUMBERS.

8. The following exercises should be dictated to the student by some one, at first slowly, especially the divisions, and then more rapidly, until at last he or she will find that the operations can be performed almost as quickly as the reader can say them.

9. We give a short example, which we will write out in full, as it ought to be dictated: 5; $\times$ 3; + 1; $\surd$; $\times$ 7; $-$ 1; $\div$ 3; sq.; $-$ 1; $\div$ 10; cube; $-$ 12; $\div$ 100?

Take the No. 5, multiply it by 3, add on 1, take the square root, multiply it by 7, take away 1, divide it by 3, square, take away 1, divide it by 10, cube, take away 12, and divide by 100. Ans. 5.

The separate answers, which the student ought not even to whisper are, 15, 16, 4, 28, 27, 9, 81, 80, 8, 512, 500, and 5 the Answer.

10. Questions of this kind are usually set in the following form in papers on this subject, viz.: $[(19 + 73 - 46)^2 - 10] \div 9 = x$; $x(x - 34) = ?$ This reduced to the form in 9, is 19; + 73; -46; sq.; -10; $\div 9$; -34; which $\times$ by last result but one ? of which the separate answers are 92, 46, 2,116, 2,106, 234, 200, and (200×234), 46,800 Ans.

11. The example in 10 is rather more difficult than those to be found at the end of this chapter, since it includes the squaring of a number larger than 12, and the multiplication of a number which the student has in his head and not before him.

12. The symbol x is not used in any set of questions we have seen given to female candidates. Questions of this kind prepared for them are as follows:—

$$(58 - 39 + 66) \div 17 - (63 - 85 + 79) \div 19 + (83 + 56 - 47) \div 23?$$

which cannot be reduced to the form given in 9, as properly speaking it implies, according to the accepted usage of the order in which signs are to be taken, some additional brackets, and ought perhaps to be written thus:—

$$[(58 - 39 + 66) \div 17] - [(63 - 85 + 79) \div 19] + [(83 + 56 - 47) \div 23]$$

or $(85 \div 17) - (57 \div 19) + (92 \div 23)$

or $5 - 3 + 4$ or 6.

13. In performing the operation in 12, the work might be done thus:—

$58 - 39 + 66$ would become in one's mind $51 + 7 - 34 - 5 + 66$ or $51 - 34 + 68$, and this $\div 17$ is $3 - 2 + 4$, or 5. Again $63 - 85 + 79$ would probably become in one's mind $63 - 63 - 22 + 79$ or 57 and this $\div 19$ is 3 which being taken from 5 leaves 2; lastly, $83 + 56 - 47$ would naturally become $83 + 55 - 46$ or $138 - 46$, and this divided by 23 is $6 - 2$ or 4, which being added to 2 gives us our Answer, 6.

14. If these exercises are performed in this way, and not at all as they are done on paper, they become intensely interesting, and by no means wearying,

whereas we feel sure that to do them with the mind as we write them, retaining the numbers in their proper places, &c., is by no means a useful exercise, and to some minds extremely irritating.

15. Let us do one more and try and analyse the method which we adopt, not that we doubt for a moment that there are other ways of performing the operation which would commend themselves to certain minds.

$$[(19 \times 3) - 5\,(17 \times 2) + 6\,(21 - 2)] \div 18.$$

Remembering that we have to divide by 18, the three expressions to be so divided might be mentally resolved thus:—

$$\begin{aligned} 19 \times 3 &= 18 \times 3 + 3 \\ -5\,(17 \times 2) &= -5 \times 18 \times 2 + 10 \\ 6\,(21 - 2) &= 6 \times 18 + 6 \end{aligned}$$

hence we have $(3 + 6 - 10)\,18 + \frac{10}{18}$, or $\frac{1}{18}$.

16. Here is another exercise:—

5 shillings; pence; + 3; ÷ 7; × 4; shillings; × 12; + 6; guineas; × 5; + 3s.? which may be dictated thus: take 5 shillings, reduce them to pence, add on 3 (pence since no special denomination is mentioned), divide by 7, multiply by 4, reduce to shillings, multiply by 12, add on six (shillings), reduce to guineas, multiply by 5, add on 3s. £10 13s. Ans.

17. EXAMPLES I.

1. 5; + 2; × 2; − 2; × $\frac{3}{4}$; $\sqrt[2]{}$; + 7; sq.; + 8; × $\frac{7}{12}$; + 1; $\sqrt[2]{}$; $\sqrt[3]{}$; − 2?

2. 7; + 12; − 3; $\sqrt[2]{}$; × 5; + 7; $\sqrt[3]{}$; × 12; × $\frac{3}{5}$; $\sqrt[2]{}$; × 8; + 3; × $\frac{6}{7}$; − 1; ÷ $\frac{1}{7}$; − 2; sq.; − 4; × $\frac{3}{7}$; + 4; $\sqrt[2]{}$?

3. 4; cube; $\sqrt[2]{}$; + 3; sq.; − 1; $\frac{7}{10}$; + 1; ÷ 5; − 1; $\sqrt[2]{}$; × 19; − 1; × $\frac{3}{5}$; − 1; $\sqrt[2]{}$; × 11; × 2; − 4; × $\frac{3}{5}$; $\sqrt[2]{}$; − 2; $\sqrt[3]{}$?

4. 7; sq.; × 2; − 3; ÷ 19; sq.; − 1; × $\frac{3}{8}$; sq.; + 3; × $\frac{4}{7}$; + 4; $\sqrt[2]{}$; + 1; sq.; × 2; + 7; $\sqrt[2]{}$; − 1; sq.; − 4; × $\frac{1}{2}$; + 2; × $\frac{5}{9}$; ÷ $2\frac{2}{3}$?

5. $\frac{2}{3}$; × 10; sq.; × 3; ÷ 16; sq.; sq.; − 1; ÷ $2\frac{2}{3}$; sq.; + 100; $\sqrt[3]{}$; + 1; sq.?

6. $4\frac{1}{2}$; × 5; × 3; − $1\frac{1}{2}$; × $\frac{3}{11}$; − 2; $\sqrt[2]{}$; cube; × 2; − 2; ÷ 7; ÷ 2; $\sqrt[2]{}$; cube; + 1; × $\frac{4}{7}$; × 9; $\sqrt[2]{}$; + 2; ÷ $2\frac{2}{3}$; − 1; $\sqrt[2]{}$?

7. $9\frac{1}{2}$; × 2; × 4; − 1; ÷ $4\frac{1}{8}$; × 2; $\sqrt[2]{}$; × 5; + 2; × $\frac{3}{8}$; ÷ $1\frac{1}{11}$; sq.; − 1; × 2; − 90; ÷ $4\frac{1}{8}$; $\sqrt[2]{}$; + 9; sq.; + 25; $\sqrt[2]{}$?

8. $8\frac{1}{4}$; × 4; × $\frac{8}{11}$; $\sqrt[2]{}$; × 27; $\sqrt[2]{}$; × 17; ÷ $4\frac{1}{4}$; + 2; $\sqrt[2]{}$; × $21\frac{1}{3}$; − 2; ÷ $\frac{7}{11}$; + 2; × $\frac{1}{2}$; $\sqrt[2]{}$; + 3; sq.; + 1; × $\frac{8}{17}$; − 1; $\sqrt[2]{}$; × 19; − 1; × $1\frac{1}{2}$; $\sqrt[2]{}$; × 4; + 1; ÷ $7\frac{1}{2}$; × 14; × $\frac{8}{11}$; + 1; $\sqrt[2]{}$; × 7; × 3; + 18; $\sqrt[2]{}$; + 2; sq.?

9. $3\frac{3}{8}$; × 6; × $\frac{8}{11}$; sq.; − 1; ÷ $\frac{7}{11}$; − 1; × $\frac{3}{7}$; + 7; $\sqrt[2]{}$; × 18; − 5; $\sqrt[2]{}$; × 9; + 9; × $\frac{7}{12}$; + 1; $\sqrt[2]{}$; × 13; − 4; $\sqrt[2]{}$; × 16; + 9; ÷ $4\frac{1}{2}$; + 3; × $\frac{8}{9}$; $\sqrt[2]{}$; × 21; + 18; $\sqrt[2]{}$; + 3; sq.; − 25; × 3; + 25; ÷ 25; $\sqrt[2]{}$?

10. $5\frac{1}{2}$; × 3; − $\frac{1}{2}$; $\sqrt[2]{}$; × 18; × $\frac{8}{11}$; sq.; + 100; $\sqrt[3]{}$; × 6; × $\frac{5}{8}$; − 1; $\sqrt[2]{}$; ÷ $2\frac{1}{2}$; × 25; ÷ 7; × 2; ÷ 3; × 14; $\sqrt[2]{}$; × 6; + 3; × $\frac{3}{8}$; $\sqrt[2]{}$; × 6; − 6; $\sqrt[2]{}$; × 5; − 5; $\sqrt{}$; × 4; − 4; $\sqrt[2]{}$; × 3; − 3; $\sqrt[2]{}$?

11. $[(15 + 18) \div 3] \times 9 + 6 = x$; $[(x \div 5) + 39] \div 12 = ?$

12. $[(15 + 17) \div 8] \times 7 = x$; $[(x + 8) \div 6] \times 5 - 15 = ?$

13. $[(55 - 31) \div 8] \times 11 = x$; $[(x + 6) + 9\frac{1}{2}] \div 5 = ?$

14. $[(18 + 14) \div 5\frac{1}{3}] \times 6\frac{3}{8} = x$; $[(x \times 4) \div 38] + 8 = ?$

15. $[(17 + 25) \div 1\frac{5}{6}] \times 5\frac{3}{8} = x$; $(x - 9) + 16 = ?$

16. $[(65 + 47) \div 1\frac{1}{3}] \times 1\frac{1}{4} = x$; $(x \times 7) \div 18 = ?$

17. $[(43 + 56) \div 1\frac{7}{11}] \times \frac{8}{9} = x$; $\left(\frac{x}{11} + 4\frac{1}{2}\right) \times 9 = ?$

18. $[(15 + 13 + 12) \div 8] + 25 + 16 + 19 - 14 - 17 - 13 = ?$

19. $\dfrac{71 + 17 \div 53 + 29}{17} + \dfrac{36 + 45}{9} - \dfrac{19 + 58}{11} = ?$

20. $\dfrac{7 + 15 + 42 - 24}{8} + \dfrac{35 + 46}{9} - \dfrac{329 - 161}{12} = ?$

21. $(7 \times 60) + (8 \times 61) + (9 \times 62) = ?$

22. [13s. $2\frac{3}{4}$d. + 14s. $9\frac{1}{2}$d. + 6s. $11\frac{3}{4}$d.] ÷ 8 = ?

23. $(18 + 9) \div 3 + (21 - 5) \div 4 - 4 \times (11 - 8) = ?$

24. $(16 + 6) \times 9 \div 6 - 14 + 7 = ?$

25. $[(6 \times 13) + (15 \times 3)] \div 3 - (17 \times 5) = ?$

26. $[17 + 18] \div 7 \times 9 + 16 - (15 + 6) = ?$

27. [2s. $7\frac{1}{2}$d. + 14s. $6\frac{3}{4}$d. + £3 2s. 10d. − £2 15s. 0d.] × 8 =

28. $[-(5 \times 13) + (7 \times 8) + 3\,(19 - 8)] \div 6 = ?$

29. If $x = \frac{8}{15}$ of $(100 - 9)$; find $\left(\frac{x}{7}\right)^2 - 1$.

30. If $(x + y) = 12$; and $xy = 35$; find $(x + y)\,(x - y)$.

31. If $(17 + 80 - 29) \div 1\frac{5}{8} = x$; find $\frac{1}{15}$ of $\left(\frac{x}{12} + 49\right)$.

32. If $[(19 + 35) \div 9] \times 8 = x$; find $\frac{1}{11}$ of $\left(\frac{x}{12} + 29\right)$.

33. If $[(18 + 14) \div 5\frac{1}{3}] \times 6\frac{3}{8} = x$; find $\frac{1}{38}\,(x \times 4) + 8$.

34. If $[(53 + 35) \div 1\frac{1}{4}] \times 3\frac{1}{12} = x$; find $\frac{x}{28} \times 5$.

35. If $[(27 + 50) \div 1\frac{1}{4}] \times \frac{8}{9} = x$; find $\left[\frac{x}{11} \times 3\frac{1}{2}\right] \times 7$.

36. If $\dfrac{65 + 82}{7} - \dfrac{427 + 57}{11} + \dfrac{213 + 27 - 90}{6} = x$; find $(x + 4) \times (x + 3)$.

37. If $(6 \times 72) - (9 \times 144) + (12 \times 216) - (20 \times 36) = x$; find $\frac{x}{72} \times \frac{3}{4}$.

38. 5 shillings; pence; + 4d.; ÷ 8; farthings; + $\frac{3}{4}$d.; × $\frac{4}{7}$; − $\frac{1}{4}$d.; pence; × 20; + 8s.; × 2; − 6s.; pound, &c.?

39. 4 tons; cwts.; + 4 cwts.; × $\frac{3}{17}$; quarters; + 1 cwt; ÷ 12; − 10 qrs.; lbs.; − 1 lb.; × $\frac{7}{11}$; ounces; − 1 lb.; how many lbs., &c.

40. 100 far.; × $\frac{3}{17}$; pence; × $3\frac{1}{3}$; shillings; × 3; ÷ $\frac{3}{16}$; and reduce to pounds.

41. 2 miles; fur.; − 5 fur.; poles; − 40 poles; ÷ $6\frac{1}{2}$; how many yds.?

42. 1 lb. troy; × 3; oz.; − 1 oz.; ÷ $\frac{1}{2}$; + 1 oz.; × $\frac{3}{5}$; dwts.; − 100 dwts.; × $\frac{1}{15}$; how many grains?

43. 100 in.; − 1 in.; nails; × $\frac{1}{11}$; qrs.; × 75; how many English ells?

44. 1,000 pence; + 8; ÷ $\frac{1}{2}$; farthings; × $\frac{5}{12}$; pence; × $\frac{4}{15}$; how many half farthings?

45. 4 tons; cwts.; + 4; ÷ 7; quarters; − 3 qrs.; ÷ $\frac{3}{4}$; − 34 qrs.; lbs.; ÷ $\frac{1}{2}$; + 49; grains; − 1 lb. troy; how many dwts.?

46. $[(3+7)\times 2 \div (4-2)\,5 + 5\times(3+2) - 3\times(5-3)] \div 7$.

47. If $(\sqrt{4\times 7-3}\times\frac{1}{2}) - (\sqrt[3]{5\times 13-1}\times\frac{1}{2}) + (\sqrt{3\times 4+5-1}\div\frac{1}{2}) = x$. Find $\frac{x}{x+1} + \frac{x+1}{x+2}$.

48. If $\frac{\sqrt{3\times 4+4}}{\sqrt{4\times 6+1}} + \frac{\sqrt[3]{2\times 5-2}}{\sqrt[3]{4\times 7-1}} + \frac{1}{15} = x$. Find $\frac{x}{x+1} + \frac{x+1}{x+2}$.

49. 4; × $\frac{7}{15}$; + 6; ÷ $\frac{3}{5}$; + 6; $\sqrt{\ }$; × $\frac{3}{4}$; cube; + 1; ÷ $1\frac{3}{4}$; × 2; + 4; $\sqrt{\ }$; cube; − $3\frac{1}{2}$; × 4; + 150; $\sqrt[3]{\ }$; × $\frac{7}{10}$; + 2; + $1\frac{1}{2}$; $\sqrt{\ }$; − 8?

50. If £4; shillings; + 4; ÷ $\frac{7}{12}$; − 4; + 20; pence; + 1d.; ÷ $3\frac{1}{2}$; farthings; + 8 farthings; ÷ $1\frac{1}{11} = x$. How many x's are there in 6s. $2\frac{1}{4}$?

(To be continued.)

Science Notes.

SOME curious facts are stated by Professor Darwin in his recent article on earthquakes. The sea rests on the ground, and when the tide is high a greater weight has to be supported than when it is low. A tide of only 10 feet would increase the weight by eight million tons to the square mile. Again the barometer ranges through fully two inches, and this corresponds to a weight of 1,800,000 tons to the square mile. Professor Darwin has taken a probable estimate for the elasticity of rocks. and he finds that we are some three or four inches nearer the centre of the earth when the barometer is very high than when it is very low. The Professor has also supplied two simple illustrations of the construction of a seismometer. In an earthquake there may be a motion of theearth in a horizontal direction. How is this to be ascertained. Consider a door of a railway carriage to stand open, if the train start on with a jerk the outer edge of the door will move with a recoil in the opposite direction. Since the doorpost moves in one direction and the edge of the door in another, somewhere in the door there is a line which remains still. Now if the sudden movement is imparted to the doorpost by the floor to which it is attached, it is plain that a pencil attached to the door at the vertical line will write on the floor the displacement of the post, notwithstanding that the floor has moved. But the motion may in an earthquake also be vertical. To measure this, advantage is taken of the following principle. If a weight hangs by a long elastic cord so that when it dances up and down it oscillates very slowly, then when a sudden jerk is given to the point of support, the weight will for the moment stand almost stationary, and a pencil attached to it may write its record on a surface fastened to the part jerked. Hence it is possible to construct a vertical seismograph. The surface on which the record is written is kept moving by clockwork, so that it is possible to get records both in time and space.

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DR. RONSON ROOSE has drawn attention to popular delusions in regard to infection and disinfection. Heat, exposure to air and sunlight, and certain chemical agencies are means at our disposal. The important point is how to apply these agencies. Clothes and bedding can pretty easily be exposed to hot air or steam for some hours, and then the action of sun and air will serve to complete the purification. The disinfection of the air is a more arduous task. It is simply useless to place saucers containing chloride of lime, or carbolic acid, or Condy's fluid in a contaminated atmosphere with the hope that the germs floating about therein will be caught and killed like mice in a trap. Offensive smells may be removed by using these substances, but to render the air perfectly harmless so far as the germs of disease are concerned, the so-called disinfectants must be present in such quantity as to render the air quite irrespirable. When this can be done as in the case of a room in which a child with scarlatina has been confined for some time, a neat, easy, and effective way of really disinfecting is to put some crystals of chlorate of potash in a wide mouth bottle, and strong hydrochloric acid. The bottle should be placed high up in the room. It cannot be too widely known that thorough ventilation of sick rooms is far the best means of preventing infection. Air, sun, and water, are more efficacious than chemicals. Spongy iron filters are the best, but well boiling the water can always be resorted to, and is a considerable safeguard. Milk of a suspicious character should always be thoroughly boiled.

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SIR WILLIAM THOMSON has recently given an address on the origin, amount and duration of the sun's heat. He accepts Helmholtz's form of the meteoric theory which assumes that at some period long past the sun's initial heat was generated by the collision of pieces of matter gravitationally attracted together, and that shrinkage due to cooling gives, through the work done by the mutual gravitation of all the parts of its shrinking mass, the vast thermal capacity in virtue of which the cooling has been and continues to be so slow. An essential detail of this theory is that the sun must be fluid.

The heat radiated from the sun is truly enormous. The mechanical value of the heat radiated by every square metre of the sun's surface is 2,574,000,000 foot pounds per minute; that is to say, it would require all the work which the engines in eight of the best ironclads could do to produce as much heat as is radiated from one square metre of the sun's surface. Two most interesting questions arise: how long has this astounding amount of radiation been going on, and how long will it continue? Sir William Thomson thinks it would be exceedingly rash to assume that there has been more than twenty million years of the sun's light and heat in the past history of the earth, or to reckon on more than five or six million years of sunlight for time to come.

We learn from 'Nature' that sensitive thermometers have been constructed upon a principle resembling Breguet's metallic thermometer. A spiral composed of two substances having different hygrometric co-efficients of expansion tends to curl or uncurl according to changes in the hygrometric state of the air. Some of these have been made by Prof. W. Holtz of thin brass spirals with a thin coating of gelatine on one side. Independently, M. Nodon, of Paris, has constructed some hygrometers, having spirals made of Bristol board, coated on one side with gelatine (with a little salicylic acid), and in the other with bitumen. The principle is not new; in various collections of physical apparatus similar arrangements have existed for a dozen years.

The use of common petroleum lamps has been attended with many very serious accidents. With good lamps there is hardly any danger at all. It is gratifying to hear that a cheap form of extinguisher has lately been invented and patented by Mr. E. Phillips, of 84, Bishopsgate-street. This is so fixed over the burner that directly the lamp is knocked over or dropped from the hand the flame is automatically caused to go out. The principle can be very cheaply applied, and there is no doubt but that in a very short time lamps with this safeguard attached will be in the market, and thus the poor will be enabled to have a lamp which is not only handy and cheap but also quite unattended with danger.

Notes of a Lesson on Movements of the Air.

BY JOS. H. COWHAM, F.G.S.,

Lecturer on School Method: Westminster Training College.

VI.—VARIABLE WINDS IN TEMPERATE REGIONS.

(PART I.)

INFORMATION ARRANGED UNDER HEADINGS.

ILLUSTRATIONS AND TEACHING HINTS.

A. REVISION: Statement of the causes of winds taught in previous Lessons.

1. Difference of temperature in places not far distant from each other causes a corresponding difference in air pressure.

2. There is always a movement of air from an area of high pressure towards an adjacent area of low pressure.

3. The direction of the wind movement is modified by the varying rate of rotatory movement of the earth in different but adjacent latitudes.

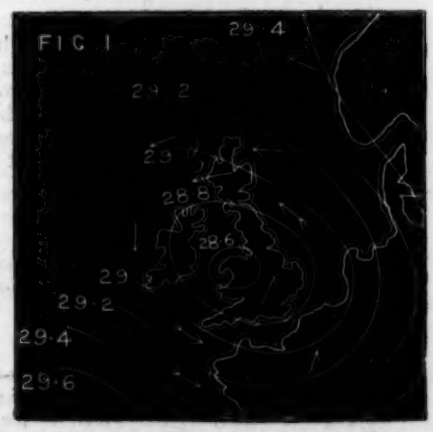
1 and 2. Refer to draught through keyhole, or open window, or up the chimney when a fire is in the room, and recall thus the truth that the air movement is due to the rarefaction of the air by means of artificial heat.

2. The lesson on Land and Sea Breezes should be briefly recalled in illustration of this movement.

3. This modification and its full explanation were given in connection with the lesson on the Trade Winds.

B. Application of these principles in explanation of variable winds in temperate regions.

1. By observations taken simultaneously at stations scattered over the whole of the British Islands the amount of air pressure at these stations is registered, and then forwarded every morning and afternoon to the Meteorological Office, London.



A Cyclonic Chart issued November 29th, by the Meteorological Office.

2. Weather charts are then prepared in the London Office showing amongst other things—

(*a*) **distribution of air pressure,**
(*b*) **direction and intensity of the wind.**

These charts are prepared in the following manner:—

(*a*) All places reported as having the same barometric pressure are joined together by a curved line. This curve is called an **isobar.**

(*b*) The direction and strength of the wind are shown by a series of arrows of slightly different construction.

C. It is found, upon examining a number of these charts, that there are two great systems of air pressure and wind movement: These are:—

1. The system in which the isobars are drawn round a centre where the pressure is lowest and from which the pressure increases as the isobars get further away. When isobars are thus arranged round a low pressure area the area is termed a **Cyclone.**

2. On the other hand when the isobars are drawn round a centre of high pressure, so that the isobars indicate lessening pressure as they are further removed from the centre. The area round the high pressure centre is termed an **Anti-cyclone.**

3. The centres of both Cyclone and Anti-cyclone are rarely stationary. They move over the British Isles generally from west to east.

The reason of this movement is not thoroughly known. It is however a fact that the air as a whole is in movement—the cold heavy air of Polar Regions changing places with the warmed and lighter air of the tropics. The Polar air generally moves southward over the continents and the Tropical air moves northward for the most part over the great oceans.

4. When a distinct Cyclone or Anti-cyclone area is formed the winds are always found to blow round the area.

If the area is an Anti-cyclone the winds in the N. Hemisphere blow round in the same direction as the watch hands. If a Cyclone the direction of the wind is opposite to the watch hands.

EXPLANATION OF CHART.

(*a*) The curved lines on the chart, Fig. 1, connect places of equal pressure. They are the *Isobars* mentioned in paragraph (*a*) opposite.

The numbers on the curves are the heights of the Mercurial Barometer in inches and tenths of inches.

(*b*) The arrows indicate the direction of the wind in various parts of the cyclone.

The shape of the arrow indicates the strength of the wind, thus :—

Light Breeze ⟶ **Strong Breeze** ⟶
A Gale ➤

C. In (1) Fig. 1 we have a representation of a well marked Cyclone, such as is common over the British Isles in July.

The isobars represent increasing pressure as they are taken outwards from the centre. Thus, at the centre the barometer registers 28·6 inches of barometric pressure, whereas over the North of Scotland, and the West of Ireland, this pressure is increased to 29 inches.

The arrow representing the lightest breeze is over the eastern counties where the isobars are furthest apart.

The winds vary in force, and are strongest off Cornwall and Yorkshire where the isobars are nearest together. **The wind circulates over the entire area in a direction contrary to the watch hands.**

Fig. 2. Chart of an Anti-cyclone issued February 4, by the Meteorological Office.

(2) England is seen to occupy the centre of the Anti-cyclone, and the pressure over the entire Kingdom is about equal, viz. 30·6 inches of barometric pressure.

Over Ireland, Scotland, and Northern France, the barometer is lower by $\frac{1}{10}$ of an inch.

In this Anti-cyclonic system the winds are very light, and **circulate in the direction of the watch hands.**

(3) Examine a number of successive charts as they appear day after day, and this movement of the whole system will be seen.

4. Compare figures 1 and 2. These weather charts are drawn from observations made by scores of men at the same time, and show very distinctly the direction the wind takes in a Cyclone and the contrary direction which it assumes during an Anti-cyclone.

(PART II.)

INFORMATION ARRANGED UNDER HEADINGS.

D. Explanation of the direction and force of the wind in a Cyclone or low pressure area.

1. The air moves naturally towards the centre or area of lowest pressure from all sides as shown by the arrows A, B, &c.

2. Owing to the different rates of earth rotation the wind at A as it proceeds southward is twisted from being a direct north wind into a north east wind.

3. On the other hand the wind at B is twisted from being a direct S. wind into one from the S.W.

4. For the same reasons (though far more difficult of application) the winds at C, D, and E move round the centre in a direction contrary to the watch hands.

5. The force of the wind is determined by the nearness of the isobars. If they are very near, *a gale* may be expected, if far apart there will be a *gentle breeze* or a *calm*.

E. Explanation of the direction and force of the wind in an Anti-cyclone, or area of high pressure.

1. The air moves again from the high pressure to the low pressure area as shown by the arrows A, B, &c.

2. If the earth did not rotate then the arrows A and B would indicate the direction of these two wind movements, but owing to the difference in the rotary movement of the earth in different latitudes, the wind at A is twisted into a S.W. wind, and the wind at B into a N.E. wind.

3. Between A and B are the winds C, D, and E, making up the circular system of winds which always blow round an anti-cyclonic area.

4. The *direction* of these winds round a centre of high pressure is always the same as that of the watch hands and the *force* is rarely high in consequence of the isobars being generally far apart.

ILLUSTRATIONS AND TEACHING HINTS.

Fig. 3. Showing direction of winds in a Cyclone area.

1. and 2. A and B represent the direction the wind would take if difference of air pressure acted alone. The dotted line represents the actual course taken by the wind owing to the earth's rotatory movement.

3. This twist of the N. wind at A into one from the N.E. is exactly like the twist of the northern Trade Wind into a wind from the north east.

4. Similarly the wind at B is turned into a S.W. wind like the S.W. Return Trade Winds.

5. In Fig. 1, there is a *gentle breeze* in Leicestershire, a *strong breeze* over Scotland, and a *gale* in the English Channel off Cornwall.

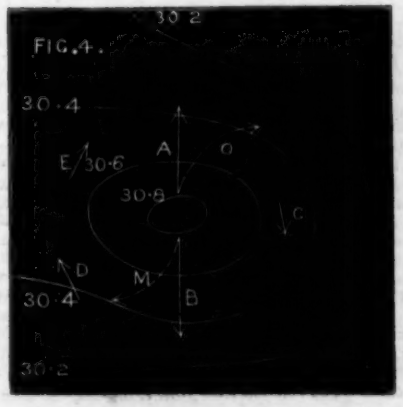


Fig. 4. Showing arrangements of wind in an Anti-cyclone area.

1. A and B show direction movement of air should take—from high pressure centre outwards to lower pressure areas.

2. The dotted lines and arrows O and M show the directions actually taken by the wind.

Refer to the twisting of the Trade Winds again. These winds are turned into N.E. and S.W. winds respectively for the same reason.

3. State and place the arrows C, D, and E as seen on the map.

4. Contrast with direction of winds in a Cyclone area and test by reference to the weather charts given in the '*Times*' Newspaper every day.

Model Answers to Certificate Questions.

BY A. BARRIBALL, B.A.

Female Candidates.

British History.

SECTION I.

1. Write a short account of the rebellion of Monmouth, and the Western Assize, or of the Massacre of Glencoe.

Monmouth, who came with three ships from Holland, landed at Lyme, in Dorsetshire. His cause was taken up heartily by the peasants, but few of the upper classes joined him. From Taunton he pressed on to Bristol, to conquer which was his chief aim, for that city was then the second in the kingdom. At Bath he began to lose courage, for the Royalists were gathering fast. He fell back to Philip's Norton, where a skirmish took place. The decisive battle was fought at Sedgmoor, near Bridgewater, where lay a Royal army of 3,000 men. Monmouth, intending to surprise them, advanced in the dead of the night from Bridgewater. He had crossed two of the rhines, or mud trenches, in silence, and had nearly reached the foe, when he found facing him another deep ditch, of which his guides had not told him. In the consequent confusion a pistol went off, and instantly the Royal troops were aroused. The rebels fought long and bravely, and when at last they fled, a thousand were left on the field slain. Monmouth, who had taken to flight at the commencement of the battle, knowing all was lost, was found two days after in a ditch near the New Forest. He was executed on Tower-hill.

The Western Assize was opened at Winchester by Judge Jeffreys. He passed through the whole circuit, delighting in massacre, and his name became a by-word for cruelty and blasphemy. Above 300 persons were executed, and numbers that escaped death were doomed to suffer mutilation, imprisonment or exile.

2. Recount the circumstances connected with the translation of the Bible into the authorised version.

When James I. ascended the English throne there were three great parties in England—the Episcopalians, Roman Catholics, and Puritans. It was soon seen that James intended to establish episcopacy throughout Great Britain. This led to a union being formed between the Catholics and Puritans, who had suffered equally from the Acts of Supremacy and Uniformity in the preceding reign, and the formation of a double plot, known as the Main and Bye plots. Both failed, and the next year a conference of leading Episcopalians and Puritans was held at Hampton Court to settle the disputes existing between the two parties. This object was not attained, however, and the only benefit derived from the conference was the translation of the Bible. The work occupied 47 ministers for three years, and was published in 1611. These 47 divided into six independent classes, to whom a distinct portion was assigned. Each member of each class had to translate the whole of the portion assigned to his class. The versions were criticised in a common assembly.

3. Who were Hampden, Algernon Sidney, and Somers?

John Hampden, a gentleman of Buckinghamshire, first rose to popular distinction on the revival of the tax called 'ship-money,' in 1634. The levying of this tax was a purely illegal act in times of peace, and Hampden refused to pay the 20s. imposed on his estate. He was one of the five Roundheads of the Long Parliament whom Charles I. tried to arrest in 1642. On the outbreak of the Civil War Hampden took an active part, and fell mortally wounded on Chalgrove Field in 1643, by one of Rupert's cavaliers.

Algernon Sidney was a son of the second Earl of Leicester. He fought on the Parliamentary side in the Civil War, and was appointed one of the judges to try Charles I.; but he was neither present, nor did he sign the warrant of execution. He went abroad at the Restoration, but returned in 1667, on receiving a pardon. He was executed in 1683 with Lord William Russell, being falsely accused of complicity in the Rye House Plot.

Lord Somers, a talented statesman and writer, was the chairman of the committee which formed the famous Declaration of Right. In politics he was a staunch Whig, and was made Lord Chancellor in Montagu's Ministry of 1697. In 1708, on the dismissal of Harley from the ministry, he was appointed President of the Council.

4. What is meant by the Self-denying Ordinance, the Solemn League and Covenant, and the Petition of Right?

The *Self-denying Ordinance* was an Act passed by the Puritans, mainly through the energies of that branch of them called Independents, forbidding members of Parliament to hold command in the army.

The *Solemn League and Covenant* was made between the Parliaments of England and Scotland in 1643. This union was chiefly brought about owing to Charles asking the Irish for help. The Parliaments pledged themselves to the union of the two Kingdoms on the basis of uniformity of religion, the abolition of prelacy, and the freedom of Parliament.

The *Petition of Right* was a Bill passed by Charles I's. third Parliament, re-asserting the hereditary liberties of England. It required the king to levy no taxes without the consent of Parliament, to detain no one in prison without trial and to billet no soldiers in private houses.

5. Recount in order, with dates, the chief engagements which took place in the Parliamentary War, and say what was the result of each.

Date.	Battle.	Result.
1642	Edgehill	Indecisive, but checked King's march on London.
1643	Wakefield	Defeat of the Royalists.
1643	Chalgrove Field ...	Royalists victorious. Hampden killed.
1643	Newbury (I.) ...	Royalists defeated. Lord Faulkland killed.
1644	Marston Moor ...	Brilliant victory for Roundheads and Scots, chiefly owing to Cromwell and his Ironsides. This battle enabled the Parliamentary troops to capture York and Newcastle.
1644	Newbury (II.) ...	Defeat of Royalists. Return of the King to his winter quarters at Oxford.
1645	Naseby...	Royalists utterly routed by Fairfax. This battle practically decided the war. Charles sought shelter in Wales.

6. What was the population of England at the time of the Restoration? What were the most important towns at this period, and how was communication maintained between them?

(*a*) The population of England at the time of the Restoration was about 5½ millions.

(*b*) The most important towns were:—London, Bristol, Norwich. The modern seats of manufacture were then only small market towns; Manchester, Leeds and Sheffield being the largest. Birmingham was just rising into notice and Liverpool was a mere village.

(*c*) The means of internal communication at this period were very imperfect. There were no canals, and the roads were extremely wretched and infested with robbers. The stage waggon and the pack-horses carried goods, the former also taking passengers. The travelling was very slow, especially in rainy weather, when the roads generally consisted of a ridge in the centre with a channel of deep mud on each side. Some attempt was made at improvement in the reign of Charles II. by the establishment of turnpikes and a postal system.

7. Which of the eminent writers of the Stuart period took an active part in political controversy? Give particulars respecting them and their works.

Francis Bacon rose into favour in the reign of James I. through the interest of the Earl of Essex. He passed through all the highest legal offices till he became Lord Chancellor. He was tried before the Lords for receiving bribes and removed from

the wool-sack. His writings are philosophical and scientific; *the chief being* his 'Essays' (58 in number); 'Wisdom of the Ancients'; 'Novum Organum'; 'History of Henry VII.'

Sir William Davenant was Poet-Laureate under Charles I., but, adopting the Royalist cause, lost that position when Cromwell succeeded to power. *Chief works*, 'Gondibert'; and an Ode called 'In Remembrance of Master William Shakespeare.'

Jeremy Taylor was a theological writer. He was one of the greatest divines of the English Church, and a consummate scholar. Having attached himself staunchly to the Royalists, he was appointed Bishop of Down and Connor at the Restoration. *Chief works*, 'Holy Living and Dying,' 'Life of Christ,' 'Liberty of Prophesying.'

John Milton, the greatest epic poet of moderntimes, became Latin secretary to Cromwell. *Chief works*, 'Paradise Lost,' written in blindness and poverty, 'Paradise Regained,' 'Lycidas,' on the death of a friend, 'Comus,' a mask.

Edward Hyde, Earl of Clarendon, an historian and statesman, was appointed High Chancellor by Chas. II. *Chief work*, 'History of the Rebellion.'

Samuel Butler was poet of the Royalist party. *Chief work*, 'Hudibras,' intended to throw ridicule on the Independents.

John Bunyan served as a soldier in the parliamentary army, he became a Baptist preacher and was imprisoned for twelve years in Bedford jail. *Chief works*, 'Pilgrim's Progress,' an allegory describing the life of a Christian as a journey; 'Holy War,' typifying the fall and Redemption of man.

John Locke, a great philosopher, employed under Shaftesbury in State affairs, stands at the head of what is called the Sensational School. *Chief works*, 'Essay on Human Understanding,' 'Letters on Toleration,' 'Treatises on Government.'

8. Narrate the circumstances which led to one of these two events—(1) The Restoration of Charles II., (2) The Revolution of 1688.

The circumstances which led to the Revolution of 1688 were:—

(1.) *The Restoration of Roman Catholicism in Great Britain.* Roman Catholics were given commissions in the army and released from all penalties. The whole church was put under a Court of Ecclesiastical Commission of seven members presided over by Judge Jeffreys. Father Edward Petre, a Jesuit, became confidential adviser of the King, and both Scotland and Ireland were placed under Roman Catholics.

(2.) Interference of James with the Universities by demanding that degrees should be conferred upon Roman Catholics, and that Catholics should be appointed to vacant presidencies.

(3.) Declaration of Indulgence giving permission to all subjects to worship in their own way.

(4.) Trial of seven Bishops for refusing to read the declaration of James from their pulpits as commanded.

(5.) Letter signed by leading nobles and clergy and sent to William, Prince of Orange Nassau, inviting him to ascend the English throne.

9. Who were the Chief Ministers of State in the time of William and Mary, and of Anne? Say which of them were suspected of treasonable communications with France, and what grounds existed for such suspicion.

(*a*) The chief Ministers of State at this period were:—Lord Somers, Chas. Montagu (E. of Halifax), Earl of Rochester, Lord Godolphin, Earl of Sunderland, Robt. Harley (Earl of Oxford), Henry St. John (Viscount Bolingbroke), Robert Walpole, Duke of Marlborough, Duke of Shrewsbury.

(*b*) The Duke of Marlborough, Lord Godolphin, and other prominent Whigs were suspected of treasonable communication with France for the restoration of the Stuarts, during William III's reign. The Duke of Marlborough induced the Princess Anne to write a penitent letter to her father; and Sir Jno. Fenwick, a conspirator, whilst in prison offered to give information against both the Duke and Godolphin, who, as he declared, were in treasonable correspondence with James and Louis.

During Queen Anne's reign Bolingbroke intrigued for the accession of James and became that prince's chief adviser.

10. Tell briefly the story of one of these battles—The Boyne, La Hogue, Dunbar, Blenheim.

The Battle of the Boyne was fought in 1690, a few miles above Drogheda. William III. having landed at Carrickfergus and joined Marshal Schomberg, advanced against James with an army of 36,000 men. The army of William crossed the river at three points, and their wading was the signal for the battle to commence. The right wing was placed under Schomberg's son, and met with some opposition from the Irish left. The King led his old Dutch Guards through the stream in face of the Irish cannonade, and having gained the bank swept their entrenchments clean. The cavalry of James fought well. One body attacked the Blues, whom they could not move, and another repulsed the third division of William's army. This mainly consisted of Danes and Huguenots and was under the command of Schomberg, who was shot in the neck while trying to recover this check. The Irish army almost immediately dispersed when once the troops of William had crossed the stream. James fled to France, and of his army 1,500 were slain, whilst the victors lost only 500.

SECTION II.

1. Say what you know about each of these persons—Wolfe, Burke, and Clive.

James Wolfe, a celebrated soldier, first saw active service in Germany during the War of the Austrian Succession, 1740—48. He was made colonel in 1758; and was selected by Pitt, though quite a young man, to command the expedition against Quebec in the following year, owing to the great proofs of power which he had already given. He was wounded in the breast, and died at the moment of victory on the plains of Abraham.

Edmund Burke, the great orator, statesman, and author, was born and educated at Dublin. He first attracted notice by his essay on 'The Sublime and Beautiful.' In Parliament he strenuously opposed Lord North's policy towards the American colonies, and while the war was going on, he advocated the recognition of their independence. He was twice Paymaster of the Forces, and he took a prominent part in the impeachment of Warren Hastings. One of his last great speeches was to denounce the excesses of the French Revolution. He died in 1797.

Robert Clive began life as a clerk in the East India Company's service, but being of a restless, passionate disposition, soon left the desk to enter the army. Here he soon rose to distinction, owing to his great military genius. In 1751 he took Arcot with 500 men, and held it against 10,000. This effectually checked the power of the French. He was appointed in 1756 to the head of an expedition to punish the Nabob and avenge the Black Hole of Calcutta. His victory at Plassey laid the foundation of the British Empire in India. Clive was then appointed Governor of Bengal, and ruled with great ability. He was made a Peer on his return to England. In 1773 he was charged by the House of Commons with having abused his power to enrich himself. Though honourably acquitted, he felt the sting so deeply that he committed suicide 1774.

2. What political events and controversies are associated with the career of John Wilkes?

John Wilkes, M.P. for Aylesbury, was the editor of a paper known as the *North Briton*. He was one of the fiercest assailants of Lord Bute, who it was generally believed had sacrificed the interests of England in his anxiety to close the Seven Years' War. Bute was followed by Grenville, who commenced by prosecuting Wilkes for a libel contained in No. 45 of the *North Briton*, in which he directly accused the King of falsehood. Being arrested by virtue of a general warrant (*i.e.*, one in which the names of the accused are not mentioned) he was sent to the Tower. Two important decisions on the part of the judges were the effects of this: (1) That general warrants were illegal; (2) That no M.P. could be imprisoned except for treason, felony, or breach of the peace. Notwithstanding this, Wilkes was found guilty of libel and outlawed 1764. He returned in four years, and was elected for Middlesex. The House of Commons refused to accept him, and he was regarded as a martyr to the cause of liberty. After having been elected four consecutive times for Middlesex he was at last accepted by the House, after which he became Lord Mayor of London.

3. Name some of the principal inventions and discoveries in the time of George III., and say to whom we owe them.

	Invention or Discovery.	Name of Inventor or Discoverer.
(I.)	Improvement of the steam-engine, and application of steam to the working of machinery. One of the first results of this was establishment of cotton manufacture...	James Watt.
(II.)	Invention of spinning-jenny ...	James Hargreaves.
(III.)	Invention of spinning-frame ...	Richard Arkwright.
(IV.)	First steam-boat launched on Clyde, 1811.	
(V.)	Gas-lights first used, 1792.	
(VI.)	Discovery of planet Uranus ...	Dr. W. Herschel.
(VII.)	Invention of Safety-lamp ...	Sir H. Davy.
(VIII.)	Discovery of Vaccination... ...	Dr. Edward Jenner.

4. What were the chief writings of Dr. Johnson, and who were his principal friends and associates?

(I.) Dr. Johnson's chief works were:—His celebrated 'Dictionary of the English Language;' 'Rasselas,' a tale; 'The Lives of the Poets;' and the Satires of 'London' and the 'Vanity of Human Wishes.'

(II.) Amongst the friends and associates of Dr. Samuel Johnson were David Garrick, Oliver Goldsmith, Thomas Gray, Henry Fielding and Dr. Taylor.

5. To what are we to attribute the loss of our American Colonies, and who were the principal persons concerned in the war?

(I.) The first cause for discontent amongst the Colonists was given in 1765, when Lord Grenville, the English Premier, imposed a tax on certain papers and parchments used in America. The Colonists resolutely opposed this tax, for they argued that as they had no share in the government of the Empire, and were not represented in the British Parliament, they had no right to pay taxes. The Stamp Act was repealed by the Marquis of Rockingham, the succeeding Premier, but the right of England to tax her Colonies was still maintained. The Duke of Grafton, while at the head of the Ministry, imposed new taxes on tea, lead, glass, paper, and painters' colours. The Americans met this new burden with the same opposition as before, and under Lord North all the taxes were repealed except that on tea. In 1773 a crisis came, when a number of Colonists, disguised as Mohawk Indians, boarded three ships in Boston Harbour, and flung the tea into the sea. The British Government then shut up the harbour, and determined to reduce the Colonists by force of arms. After seven years of warfare the independence of the United States had to be recognised by Great Britain.

(II.) On the American side the chief persons engaged in the war were:—George Washington and Marquis de la Fayette; and on the English side, Generals Gage, Howe, Burgoyne, Clinton, and Lord Cornwallis.

6. How did the French Revolution affect English politics? Give particulars.

About the time of the French Revolution the claims of the English people to a larger and more direct representation in the House of Commons were beginning to be urged. Pitt, Fox, and the Whigs generally were in favour of a reform of Parliament. Owing, however, to the excesses of the French Revolution, Pitt, Burke, and many other prominent politicians altered their views upon the matter of reform, and became opposed to extending the power of the people. The consequence of this was that such questions as Catholic Emancipation, and representation of the people in Parliament were postponed for upwards of 20 years.

Upon the execution of Louis XVI. war was declared against France by England and other European Powers. After 22 years of strife, great distress followed in England. Food was scarce, commerce almost stagnant, and taxation excessive.

The effect of the Revolution in Ireland was the formation of a society of Roman Catholics to agitate for the separation of Ireland from the Empire. Plots were formed, and correspondence held with France, the outcome of which was that a union of the two Parliaments was effected, 1801.

7. 'The history of the last two years of George the Second's reign is crowded with memorable events.' Enumerate with as much detail as you can the chief of these.

The most important events which happened in the years 1759 and 60 were connected with the Seven Years' War, and the war with the French in Canada.

(*a*) Connected with the Seven Years' War are the following events:—

Capture of Guadaloupe, defeat of French at Minden, in Germany, by English and Hanoverians, under Prince Ferdinand of Brunswick; defeat of French fleet, off Lagos, in Portugal, by Admiral Boscawen; destruction of Brest fleet in Quiberon Bay, off the shore of Bretagne, by Sir Edward Hawke.

(*b*) In Canada, General Wolfe gained the decisive victory of the 'Plains,' and captured Quebec, 1759. Both Wolfe and the French commander Montcalm were killed. The following year Montreal capitulated to the English, and the French commander, Vaudreuil, signed a deed transferring Canada to England.

(*c*) In addition to the above, Colonel Coote defeated the French at Wandewash, in the Carnatic, 1760.

8 Who were the great English writers living in the first quarter of the present century, and what were their principal works?

Name of Writer.	Chief Works.
Samuel Coleridge ...	'Ancient Mariner'; 'Christabel'; 'Genevieve'; 'Remorse.'
Thomas Campbell ...	'Pleasures of Hope'; 'Gertrude of Wyoming'; 'Lochiel's Warning'; 'Ye Mariners of England.'
Robert Southey	'Thalaba' and other poems; 'Life of Nelson.'
Sir Walter Scott... ...	'Lay of the last Minstrel'; 'Marmion'; 'Lady of the Lake'; 'Waverley Novels' (Guy Mannering, Rob Roy, Ivanhoe, Kenilworth, &c.)
Lord Byron...	'Childe Harold's Pilgrimage'; 'Don Juan'; 'Siege of Corinth'; 'Prisoner of Chillon'; 'Corsair.'
William Wordsworth...	'Excursion'; 'The Waggoner'; 'Intimations of Immortality.'
Percy Shelley	'Queen Mab'; 'Prometheus Unbound'; 'The Cenci'; odes to 'The Cloud,' 'The Skylark.'
Felicia Hemans	'Forest Sanctuary'; 'Vespers of Palermo'; 'National Lyrics.'
Thomas Moore	'Lalla Rookh'; 'The Fire Worshippers'; 'The Loves of the Angels'; 'Irish Melodies.'
Charles Lamb	'Tales from Shakespere'; 'Album Verses'; 'Essays of Elia.'

9. Give some account of the Reform Bill, and say what previous attempts, if any, had been made to improve our system of parliamentary representation?

Lord John Russell introdueed his first Reform Bill March 1st, 1831. The first reading was carried by a majority of 1; in committee, however, General Gascoigne proposed an amendment, which was fatal to the Bill, and in consequence of its being carried, Parliament was dissolved. The new Parliament consisted of a large majority of members pledged to support the Bill, which was accordingly carried in the Commons with ease. But the Lords threw it out on the second reading. A third Bill was brought in by Russell towards the close of the year, after serious riots and numerous meetings in most of the

large towns, notably at Bristol. This was again carried in the Commons, but the Lords opposed it so strenuously, that Earl Grey proposed a creation of Liberal peers. The King refused, and Grey resigned, but ultimately was restored, with permission to create as many new Peers as were necessary to carry the Bill. This, however, was not found necessary, for about a hundred Tory Peers absented themselves from the division, and the Bill became law (June 7, 1832).

Three great changes were thus made :—(1) Many pocket or rotten boroughs, as Old Sarum, were disfranchised ; (2) Several large towns, as Birmingham, Leeds, Manchester, for the first time received the right to return members to Parliament ; (3) The franchise was extended more widely among the middle classes. In towns it was given to householders paying £10 a year or more ; in country, all who owned land worth £10 a year, or paid a yearly rental of £50 or upwards were entitled to vote.

The younger Pitt was one of the first to raise the question of reform, but owing to the excesses of the French Revolution he abandoned it. In 1810 it was again brought forward by Sir Francis Burdett, but it obtained no hearing till the close of the war. In 1817 Burdett again introduced a measure of reform in the Commons, but obtained a mere handful of supporters ; while in the following year a third attempt met with still greater opposition.

10. Give particulars respecting the enterprise of the Young Pretender in 1745. Prince Charles, the Young Pretender, landed at Moidart, on the coast of Inverness, in July, 1745. He came with only seven officers, the chief of whom was the Marquis of Tullibardine. Cameron of Lochiel and many other Highland chieftains soon joined him, and he raised his standard at Glenfinnan, near Loch Shiel. Sir John Cope, commander of the Royal forces, carelessly moved forward to Inverness, and left the Lowland road unprotected. The Prince accordingly reached Perth unopposed, occupied it, and then proceeded to Edinburgh. Meanwhile Cope had conveyed his troops by sea to Dunbar, after which he advanced on Edinburgh. The rival armies met at Prestonpans, where in less than ten minutes the Pretender's army utterly defeated the Royalists. After a delay of six weeks Charles marched into England through Carlisle, Preston, and Manchester to Derby. Further, however, Lord Geo. Murray and the other officers of Charles refused to go, for they were threatened by three Royalist armies, and no stir amongst the English Jacobites had been made in their favour. Accordingly they retreated northward. At Falkirk General Hawley was shamefully beaten by the Highlanders, who reaping no advantage from this retreated to Inverness. The Duke of Cumberland, who was now in command, having followed him, reached Nairn. A battle took place at Culloden Moor (April 16th, 1746), and the Prince's troops were completely dispersed. The Young Pretender succeeded in escaping to the continent, but about 80 of his followers sufferered death, including many noblemen of distinction.

11. What do you know of the history of parliamentary reporting in England, and of its influence on public opinion and policy? Parliamentary debates and speeches were first reported towards the end of George III.'s reign, in a journal known as *Hansard's Parliamentary Debates.* This journal still exists, being entirely devoted to parliamentary news. Many different methods of abbreviating and shortening the English language for purposes of reporting were adopted, but it was not till Pitman brought out his system of phonography in 1837 that any general method prevailed. The custom since then has been for the debates to be taken down in shorthand (which copy is known as the tissue), and afterwards written out in long hand. There is now in the House of Commons the Reporters' Gallery, to which every important newspaper proprietor sends his representative, and hence we have from day to day verbatim reports of the House's proceedings. The effect of these reports is to make members more careful, accurate, and truthful in their speeches. For at any time a speech delivered by a member at some previous period can be referred to in *Hansard's Journal,* and thus any statement which has been found to conflict with one made in that speech can be exposed. Parliamentary reports enable the public to see what is going on in the House, and to determine whether the members are watching the interests of those who sent them there. This again has a beneficial influence upon members, for it behoves them to carry out the principles which they professed to hold at the electioneering times.

Male Candidates.

FIRST AND SECOND YEARS.

English History.

1. State any facts which illustrate the condition of the working classes in England in 1815—1819. What were the demands of the Chartists twenty years later? Have any of them been granted since that time?

From 1815—1819 the working classes in England were in great distress. Trade was bad, and a large number of people were consequently thrown out of employment. The passing of a Corn Law made bread very dear. Riots were frequent. In agricultural districts farms were fired ; in manufacturing towns machinery was destroyed. Laws pressed heavily on the poor, and, as they were unrepresented in Parliament, no redress could be obtained.

The Chartists demanded (1) Universal suffrage ; (2) Annual parliaments ; (3) Vote by ballot ; (4) Abolition of the property qualification for members of Parliament ; (5) Payment of members ; (6) Equal electoral districts. The property qualification was abolished in 1858. A Ballot Act was passed in 1872. By Mr. Gladstone's last Reform Bill universal suffrage was practically granted, and electoral districts were made nearly equal in population.

2. What was the general character of Canning's policy with regard to foreign countries? Illustrate your answer by reference to particular events.

In the years succeeding the fall of Napoleon I. Europe was disturbed by conspiracies and rebellions, caused by the attempts of Governments to repress the demands of their subects for greater freedom. Canning, while in power, made himself the champion of these rising peoples.

He refused to take part in crushing a rising in Spain, recognised the independence of the South American colonies, which had revolted from Spain, and sent a force to protect Portugal against France. He caused the treaty of London to be signed by England, France, and Russia, pledging them to interfere in the war between Turkey and Greece. This led to the independence of the latter Power.

3, What legislative advances in religious toleration were made in England and Ireland in 1828, 1829? Who were the statesmen engaged in them?

In the reign of Charles II. the Corporation and Test Acts were passed, providing that no one should hold any important office under the Government, unless he received the Holy Sacrament according to the rites of the Church of England. These Acts pressed heavily on Catholics and Dissenters. Chiefly through the efforts of Lord John Russell a declaration of friendlincss to the Church of England was substituted for the test (1828).

Agitation for the emancipation of Catholics now arose in Ireland, headed by Daniel O'Connell. Yielding to this pressure Sir R. Peel and the Duke of Wellington introduced a Bill which placed Catholics and Protestants on an equal footing. (1829.)

4. State the leading provisions of the Reform Bill ; and give a short account of it from its introduction in 1831 to its passing in 1832.

The main principle of the Bill was that boroughs having a population less than 2,000 should cease to return members, and those having less than 4,000 should only return one member. 56 boroughs were disfranchised, and 31 lost one member. Large towns lately grown into importance received seats, and between 40 and 50 new boroughs were created. The larger counties were divided into districts. The franchise was extended.

In counties three new classes of voters were introduced, viz. : (1) copyholders of £10 per annum ; (2) leaseholders of the annual value of £10 for 60 years, or £50 for 20 years ; (3) occupiers paying an annual rental of £50.

In boroughs the franchise was given to £10 resident householders.

The Bill was introduced in March, 1831, by Lord Russell. It was received with derision by the Tories. It was opposed by the Court, the Lords, clergy, army, navy, and universities, and was supported by the press, manufacturers, and the body of the

people. The second reading was carried by a majority of one. The Government were twice defeated in committee, and decided to dissolve Parliament. The elections resulted in the return of a large majority of reformers. The Bill was brought up in July, and, after long debates, finally passed the Commons in September. In the House of Lords the Bill was opposed by the Duke of Wellington, Lord Lyndhurst, the Chief Justice, and the Archbishop of Canterbury, and was rejected. This caused great excitement in the country. Terrible riots occurred at Bristol and other places. Parliament met again in December, and the Bill passed the Commons in March. In the Lords the Bill passed its second reading with the help of a section called 'Waverers.' In committee an amendment was adopted. As the King refused to create new Peers the Ministry resigned. The Tories could not form a Ministry, so Lord Grey was re-called. The King now authorised the creation of a number of new Peers necessary to ensure the passing of the Bill. The opposition then collapsed, and the Bill became law in June, 1832.

5. What were the causes of the Canadian rebellions of 1839, 1840? Give a brief account of Lord Durham's administration and recall.

Canada was divided into two provinces, the Upper and Lower, each having its own governor, executive council appointed by the Crown, and Representative Assembly, the members of which were elected for four years. Lower Canada was inhabited chiefly by the descendants of French settlers, who lived on in a simple fashion without heeding the civilization around them. They regarded with jealousy all legislation which seemed to favour the English settlers. In this way a dispute arose between the Assembly and the Council. The former complained to the Home Government of the arbitrary conduct of the governors, and the composition of the council. The speeches of Mr. Papineau and other leaders inflamed the people. The governor ordered numerous arrests. These were resisted, and thus the rebellion arose, and soon extended to Upper Canada. Lord Durham arrived in Quebec in May, 1838. He issued a proclamation stating that he would severely deal with all law-breakers, and promising to form a new system of government. His powers were limited by the passing of the Canada Bill, and complaints were soon heard against his arbitrary conduct, with demands for his recall. He returned to England in disgrace, and died shortly after. His report was the foundation of Canadian prosperity.

6. How did the Corn Laws affect the poor? Name the leading persons engaged in their repeal. What circumstances in Ireland hastened the repeal?

No foreign corn could be admitted to English ports until the price of English wheat had reached 80s. per quarter. This made bread very dear. The wages of the working classes were low; consequently, after buying the bread necessary for their support, little was left for meat, and many other articles of food, clothing, &c., now considered as necessaries. The chief persons engaged in the agitation for the repeal were C. P. Villiers, Bright, Cobden, Milner Gibson, and W. J. Fox. Lord John Russell wrote in support of the movement, and the Bill was introduced by Sir R. Peel.

The repeal was hastened by the failure of the potato crop in Ireland, in 1845. The peasants of the south and west depended almost entirely upon this for food. The result was a famine, attended by fever, which killed the people by hundreds.

7. What events are connected with Cabul and Jelalabad in 1841, 1842; Ferozeshur and Goojerat in 1845, 1848; Canton and Pekin, 1857, 1860; Magdala in 1868?

Dost Mahomed, the ruler of Afghanistan, was dethroned in 1839 by an English force, because he was suspected of intriguing with Russia. Shah Soojah was placed on the throne, and a small force left to assist him. In 1841 a rebellion broke out in Cabul, headed by Akbar Khan, a son of Dost Mahomed. The troops were overpowered by the rebels, and were obliged to come to terms. The British Envoy, Sir W. Macnaghten, was treacherously murdered. In their march from Cabul all the army perished save Dr. Brydon, who brought the news to Jelalabad. This place was defended by Sale, until he was relieved. Cabul was retaken, 1842, and the Grand Bazaar burnt as a punishment.

In 1845 the Sikhs, inhabitants of the Punjab, made an inroad on British territory. They were defeated by Gough and Hardinge at Ferozeshur, Aliwal, and Sobraon. War again broke out in 1848, owing to the murder of British officers at Mooltan. After an indecisive battle at Chillianwallah, the Sikhs were defeated at Goojerat, and their territory annexed. In 1856 the Chinese authorities seized a vessel, the 'Arrow,' said to be English. Yeh, the Governor of Canton, refused to give satisfaction, and in 1857 Canton was captured by English and French, Yeh being taken prisoner. In 1860 an expedition was sent to Pekin. The Taku forts were captured, and Pekin taken. As a punishment for the ill-treatment of English prisoners, the Emperor's summer palace was burned.

In 1867 a dispute arose with Theodore, King of Abyssinia. He imprisoned Consul Cameron and other British subjects, and refused to liberate them. An expedition was sent against him under Sir Robert Napier. Magdala was taken, and Theodore committed suicide.

8. State briefly what you know of Daniel O'Connell, Smith O'Brien, and James Stephens. What is meant by the repeal of the Union? In what respects does Ulster differ from the rest of Ireland?

Daniel O'Connell was a great Irish leader from 1828 to 1847. He had a large frame, expressive features, and voice of remarkable sweetness and power. The passing of the Catholic Relief Bill was mainly owing to his efforts. In politics he was a thorough Liberal. He had absolute control over the Irish, and prevented them from all excesses. In 1844 he was tried for sedition, and sentenced to 12 months' imprisonment and a fine of £2,000. This was reversed by the House of Lords. He died at Genoa, 1847.

Smith O'Brien was the leader of the Young Ireland party in 1848. He was descended from Brian Boru, an ancient Irish king, and had considerable influence in the country. On the outbreak of the rebellion he was arrested and condemned to death. This sentence was changed to transportation. He afterwards received a pardon, and died in Wales, 1864.

James Stephens was the Head Centre of Fenianism in the United States. He had taken part in the rebellion of 1848. In 1866 he visited Ireland and was lodged in Richmond Prison, Dublin. He escaped and was not again taken.

By the Repeal of the Union is meant the passing of a Bill cancelling the Act of Union of 1800, and the re-establishment of a separate Irish Parliament.

Ulster differs from the rest of Ireland chiefly in race, religion and occupations of the people. Most of the inhabitants are descendants of English and Scotch settlers, whose religion is Protestant. They do not depend so much on agriculture as the rest of the people, but large numbers are engaged in manufactures.

9. Who were our allies during the Crimean War? Why was Sebastopol selected for attack? Describe shortly the character of the battles of the Alma, Balaclava, and Inkerman.

Our allies during the Crimean War were the French, the Turks, and the Sardinians. Austria rendered assistance by occupying the Danubian Principalities, leaving the Turkish army free to act in the Crimea.

Sebastopol was selected for attack because it was a strong fort from which Russia could at any time despatch an expedition against Turkey, and because it might be attacked by both land and sea. The Battle of the Alma was a vehement and obstinate attack upon the Russians for the possession of the redoubt on the opposite side of the river. It was most stubbornly contested. At Balaclava the Russians made a bold and brilliant attempt to capture the British position. It was mainly a cavalry action, which did more credit to soldiers than generals. Inkerman may be described as a series of fierce, hand-to-hand fights. Strategy was entirely absent. This was the severest action of the campaign.

10. How had India been governed previously to 1858? What change was then made? What circumstances led immediately to that change?

India was formerly governed by the East India Company, but previously to 1858 it had lost some of its power. A board of directors, chosen partly by the company, and partly by the crown, held meetings in Leadenhall-street, and gave general directions for the government of India. A parliamentary body, called the board of control, had the power of revising the directors' decision. The governor general was nominated by the crown, but could be recalled only by the company.

In 1858 an Act was passed transferring the powers of the company to the Crown, represented by a Secretary of State, assisted by a Council of India, to consist of 15 members. The governor-general was to be assisted by a council. The circumstances which immediately led to the change were terrible rebellions, which broke out chiefly in Northern India, to which has been given the name of the Indian Mutiny.

11. What was the attitude of England during the great American Civil War? What circumstance nearly led to war with the Northern States? What effect did the war have upon English manufactures?

At the outbreak of the American war the English Government issued a proclamation of neutrality, warning her Majesty's subjects from assisting either side. At first the feeling in this country was in favour of the North, but when the Southern States were not allowed to secede quietly, indignation arose against the North. English shipbuilders were allowed to fit out vessels for the South, and England became the naval base of the Confederacy.

The Southern States were desirous of being represented at Paris and London, and sent envoys for that purpose. While sailing from Cuba in the British mail-steamer, Trent, they were seized by Captain Wilkes, of the northern sloop, San Jacinto. This event nearly led to war, but it was avoided by the liberation of the envoys.

The war stopped the supply of raw cotton to our manufacturing towns. Large numbers were thrown out of employment, causing great distress. In the end more cotton was brought from India and Egypt.

12. Give some idea of the state of education previous to the Act of 1870, and state the leading provisions of that Act. Upon what point did the principal difficulties arise during its progress through the House of Commons?

Previous to the Act of 1870 education in England was far inferior to that of other great countries. It was thought that it was not the business of the Government to provide for the education of children. Private charity and a small Government grant sufficed to educate not more than one-third of the children of the country. Mr. Forster's Bill proposed to establish School Boards, elected by ratepayers, and supported by rates, fees and Government grants. These Boards had power to compel the attendance of all children between the ages of five and twelve, within their district. Existing denominational schools, if efficient, were to receive grants, on condition that they submitted to examination by a Government inspector, and accepted a conscience clause. Free schools were to be established in very poor districts. The chief difficulty arose on the subject of religious instruction. Nonconformists objected to State aid being given to any but undenominational schools. As a compromise a conscience clause was adopted, allowing parents to withdraw their children from religious teaching, if they wished to do so.

13. Give an outline of a lesson to an advanced class upon the Executive Government, with special reference to—(1) The Prime Minister; (2) The Cabinet; (3) Resignation of Ministers; (4) Permanent Officials.

Introduction.—Executive Government consists in the administration of the laws, and the direction of the relations with Foreign Powers. The Sovereign is nominally the head, but all real power is vested in Ministers.

(1) *Prime Minister.*—Head of Government. May be a member of either House. He is authorised to form a Government by the Sovereign.

Ask class to name recent Prime Ministers.

(2) *The Cabinet.*—Consists of the heads of the chief departments. Chosen by the Prime Minister, with whom they consult concerning affairs of government. *Chief members.*—Lord Chancellor, Chancellor of the Exchequer, Secretaries of State for Home, Foreign, and Indian affairs, Colonies, War. Illustrate their duties by reading report of Cabinet Council.

(3) *Resignation of Ministers.*—Ministers hold office as long as they have the support of a majority of the House of Commons. When defeated, they send in their resignation to the Sovereign. If accepted the chief of the opposite party is sent for. Illustrate by recent resignations.

(4) *Permanent Officials.*—Show how inconvenient it would be for every Government official to resign with the Ministers. Name some of the chief permanent officials, and describe their duties.

Domestic Economy.

1. If children are taught in ill-ventilated rooms, why should any harm result to them? By what methods and appliances may good ventilation be best secured in a school-room?

(*a*) In an ill-ventilated room the bad air finds no means of exit, and remains to be breathed over again by the children. Air having already passed through the lungs is rendered impure by the presence of too much carbonic acid gas. Now pure CO_2 is a deadly poison, if inhaled, and though as present in the atmosphere (in proportion of 4 parts in 1000) it is, comparatively speaking, harmless, its deadly effects are felt if this proportion is by any means considerably increased. If some of the oxygen of the air is displaced by this CO_2 the effect is much worse. The blood is sent into the lungs to be purified by the exchange of its CO_2 for the O of the air, and if the supply of the latter be insufficient the blood returns to the general circulation, not purified, and the tissues are improperly nourished.

(*b*) 1. By a judicious method of utilizing the means offered by ordinary windows, and doors opposite windows.

2. Upper panes of windows made to open.

3. Board placed in front of lower edge of window, prevents draught, sends air *up*.

4. By fireplace, if open it forms a natural ventilator; valves above grate to send out warm air.

5. Tobin's tubes; air admitted directly from outside, carried up by shaft into the room, and gradually dispersed.

6. Chambers in walls, near ceiling, &c., into which air is admitted by a grating—closed on room side by valves.

2. What difference should be made in the way of stewing meat which is meant to be eaten, as distinguished from meat intended to make soup? Give your reasons.

For eating.—In dishes made thus the *meat* is of equal importance with the liquid, and hence care must be taken not to rob the meat of all its nourishing properties. Hence (1) it is stewed rather more quickly than meat for soup; (2) not quite so much water is added; (3) larger pieces of meat are used; (4) during this stewing the meat is flavoured according to the dish prepared.

For Soup.—(1) Coarser parts of meat and bones are used; (2) Everything must be done to extract all the nourishment of the meat. Therefore smaller pieces, temperature more gradually raised, and much longer time taken; may be allowed to simmer gently by the side of fire till it will form a jelly.

3. If an artisan earns 28s. a week and has a wife and two children, how could his week's wages be most wisely spent? Specify particularly the kind and quantity of food which it would be possible and right to buy.

The artizan's wages might be thus spent:—

	s.	d.
Food	14	6
Rent	5	0
Clothing	4	6
Firing	1	6
Schooling	0	4
Saved	1	0
Incidental	1	2
	£1	8	0

Kind and Quantity of Food—possible and right.

Meat.—Ox cheek, 1½ lbs.	0 7½	
One sheep's head	0 9	
Beef, 1½ lbs.	1 0	
Liver, 1 lb. 4½d.; bacon, 6d.	0 10½	5 0
Breast mutton, 2 lb. ...	0 9	
Fish, 3 lbs., or tripe, 1½ lbs.	1 0	
Bread.—4 lbs. per day, at 5d.		2 11
Vegetables.—Potatoes, onions, greens, carrots, turnips, 2d. per day		1 2
Cheese, ¾ lb., 6d.; *butter*, 1 lb., 1s. 2d. ...		1 8
Milk and Eggs		0 10
Tea, ½ lb., 10d.; coffee, ¼ lb., 2d. ...		1 1
Sugar, 3 lbs.		0 6
Flour, 6d.; suet, 4d.		0 10
Sundries.—Rice, treacle, pease, oatmeal, &c.		0 6
		14 6

4. It is said that, for a sound system of house drainage, attention is specially needed to—(*a*) disconnection, (*b*) ventilation, and (*c*) trapping. Explain the nature and importance of these three points.

Disconnection.—By this is meant that the various pipes by which the waste from different parts of the house to the common house drain which carries them to the sewer, should not communicate with it *directly*. The connection should be either completely broken, or continued only through strong and efficient traps. For instance, the waste pipe from the bath should be carried first outside the house instead of passing directly through the soil to the drain, and should end a short distance above the ground and over a trap and grating. If not there will be no safeguard against foul gases rising up through the pipes and into the house when nothing is passing down.

Ventilation.—To all soil pipes, drains, traps, and sewers, small pipes or shafts must be connected leading up into the open air, and opening there at some distance from any window, chimneys, &c. This is to allow of the foul gases generated in these pipes to be carried off and harmlessly diffused. For if some such outlet be not provided, on any obstruction in the drains and pipes or accumulation of these gases, they must inevitably find their way into the house.

Trapping.—Traps are by law required to be placed at the junction of every house drain with the sewers, and are also necessary at other parts of the drainage system. Though of many varieties they are essentially the same in principle, all being modifications of the syphon trap. They are always full of water, and are intended to intercept any gases that might force their way back into the house system.

5. What are the proportions of strength-giving and flesh-repairing matter to be found in each of these substances :—Peas, lean meat, bread, oatmeal, rice, and cheese?

In 1,000 parts	Soluble Albumen and Hæmatin and Gelatine	Fat	Cellulose cell membrane	Starch	Dextrine	Sugar	Water	Salts
Peas	235	18·9	18	552·6			...	23·6
Lean Meat	22	175	...	...	...	...	775	8
Bread	156	18	27	577	66	...	149·5	23
Oatmeal	127	48·5	62	535	81·6	...	94·6	28·7
Rice	64	7	10	811	9	...	151·4	3·5
Cheese	40	40	...	...	...	40	874	6

6. What is the ordinary or normal temperature of the human body in health, and by what means can it be kept uniform?

The normal temperature of the body is 98·4° F., and is kept uniform in the following ways :—

1. *Regulation of Diet to Season.*—In winter, when the surrounding temperature is lower than that of the body, means must be taken to keep up the heat of the body so as to neutralize its chilling influence. Instinctively foods that are most heat-giving are eaten in larger quantities than in summer.

2. *Variations in Clothing.*—So arranged as to facilitate or check the loss of heat from the skin by alternate uses of food, or non-conductors of heat as material of clothing.

3. *Amount of Exercise.*—Instinctively in winter brisk physical exercises and more energetic movement of all parts of the body are resorted to. Vital processes are quickened and greater heat is evolved.

4. *By Skin*, which is a most important regulator of temperature. The influence of heat upon the nervous system is such that a fuller supply of blood is sent to the skin, and there is therefore a greater loss of heat by evaporation. Cold has the opposite effect, and in winter there is little loss of heat by evaporation.

7. Make out, as for the highest class in your school, the scheme for a year's course of weekly lessons on cottage cookery and sick cookery.

The year's course would consist of 40 lessons, each lasting about two hours :—

1. Preparation of vegetables. Pea-soup.
2. To boil beef. Boiling potatoes.
3. Roast heart. To make gravy.
4. Irish stew. Mashed potatoes.
5. To fry fish. Melted butter.
6. Boiled mackerel. Fish cakes.
7. Sheep's head. To boil rice.
8. Haricot mutton. Stewed fruit.
9. Cornish pasties. Plain pastry.
10. Stewed kidney. Yorkshire pudding.
11. To make bread.
12. Liver and bacon. To boil greens.
13. Brazilian stew. Tomato sauce.
14. Shepherd's pie. Suet dumpling.
15. Lentil soup. Treacle pudding.
16. Bread pudding, baked.
17. Sea pie. Fruit pudding,
18. Meat pie. Pastry.
19. Rabbit boiled. Steamed potatoes.
20. Steak and kidney pudding steamed.
21. Tripe in milk. Onion sauce.
22. Fruit pie. Pancakes.
23. Broiling. Toad in hole.
24. Meat pudding. Boiled cauliflower.
25. Vegetable soup. Plum cake.
26. Giblet pie. Savoury rice.
27. Plum pudding. White sauce.
28. Sausages, boiled and fried. Sausage rolls.
29. Beef tea. Long. Raw. Quick, &c.
30. Mutton broth. Toast-water.
31. Porridge. Milk pudding.
32. Rice pudding. Semolina pudding.
33. Rissoles of cold meat. Barley water.
34. Lemonade. Apple water. Arrowroot.
35. Boiled cod. Cup pudding.
36. Milk soup. Solid tea or coffee.
37. Maccaroni pudding.
38. To boil and poach eggs. Sago pudding.
39. Rice milk. Savoury cod.
40. Revision. Methods of cooking.

8. Explain the working and respective advantages of benefit clubs, of annuities, of life assurance, and of co-operative societies.

Benefit Clubs.—In these a member by paying certain weekly subscriptions is entitled to certain benefits in time of need. Among these are : Medical attendance in illness, support in times of temporary poverty, payment of burial expenses of deceased member, and relief to deceased member's family. Thus the strong are made to aid in the support of the weak and poor, for the subscriptions of members requiring no aid are devoted to the relief of the less fortunate.

Annuities.—The weekly payment of a small sum, or the immediate payment of a much larger sum, entitles a person to a yearly income, varying in proportion to the premiums paid, every year after attaining a certain age—or enough may be paid down at once to insure an income every year for life, and starting *immediately*.

Life Assurance.—A premium, varying in amount, paid at stated periods, will entitle the relatives of the person whose life is thus insured to the payment of a much larger sum at his death. Thus, at the age of 20 an annual payment of about £1 16s. will cover an insurance of £100.

Co-operative Societies.—Shop-keeping on a large scale. Not one, but several are the proprietors of the business. Their united capital is expended in fitting out large stores usually with the intention of supplying the public with articles in constant demand in larger quantities and at cheaper rates than they can be had elsewhere. Well managed, the principal thus laid out brings larger profits; for the greater facilities offered to buyers, and the comparative cheapness of goods, result in a rapidly increasing trade; and this profit forms the interest on the shareholders' money.

9. What are the risks of impurity to which drinking-water is exposed: (*a*) in the rural cottage, and (*b*) in the town house? How would you propose to provide against them in each case?

(*a*) *Cottage.*—The water is here taken (1) from a stream or river, in which case it may have been contaminated by refuse matters from towns, houses, or factories on its banks higher in its course, or by decaying animal or vegetable matters accumulated during its course. Such water must be boiled and then filtered. (2) *from wells*, which may be only surface wells, and receive the drainage of the land, cesspools, refuse heaps, &c., and be the source of most deadly infection. Such wells should be replaced by well constructed deep wells, having cemented sides, and the water in any case should be filtered.

(*b*) *Town.*—Chief risks: (1) From nature of supply pipes. Often made of lead, which may be acted upon by the water, which is rendered poisonous. To be free from all danger these pipes should be of cast iron; (2) *iron cistern* (*a*) Impurities may arise from the nature of the cistern, especially in the case of lead, zinc, or timber cisterns. They should be made of galvanized iron, with well fitting lids, easily reached, and cleaned often; (*b*) a badly arranged cistern is a fertile source of danger. Too often the overflow pipe is carried directly to the w.c., or the same cistern is used to supply all the needs of the household. The overflow pipe should be carried outside the house and end there, and the cistern that supplies the w.c. should be used for no other purpose whatever.

10. Give a short account of the discovery of vaccination. What objections have been made against it? and what are the arguments in its favour?

(*a*) Before the introduction of vaccination (1796) small pox existed in a form so severe that we can now hardly conceive how loathsome it was. About 1795 Dr. E. Jenner was engaged in testing the truth of a rumour that had existed some time that an attack of cowpox brought immunity from small pox. He made several experiments. A boy was inoculated with cowpox, and then repeatedly with smallpox, but without any result.

As all his experiments confirmed this result he soon after made the facts of his observations public. Dr. Woodville followed up this discovery and treated about 7,000 successfully.

The practice soon became general and has been made compulsory by Government with the happy result of a wonderful decrease in the number of deaths from small pox.

(*b*) (1) The remarkable decrease in number of deaths from small pox since its introduction: (2) Statistics show the number of deaths among those not vaccinated is very much higher than among those properly vaccinated. In one small pox hospital in a certain time the number of deaths among the former=46 per cent., among the latter 3½; (3) Cases in which small pox has been taken after one attack, and in spite of vaccination, may be accounted for as may second and third attacks of measles, &c., by the peculiar liability of some to catch certain diseases; (4) The remedy is so simple compared with the dreadful nature of the disease; (5) No other remedy has been found having anything like its efficacy.

11. If you allot four hours a week to the teaching of needlework to girls; say how the time is best distributed—whether in four separate lessons of an hour each, or two of two hours each, or otherwise. Say what plan you intend to adopt, and why?

The time is best distributed in two lessons of two hours each, and for the following reasons:—

1. The time is not too long to cause any undue strain upon the children.

2. An appreciable amount of work can be got through in the time, while in one hour very little comparatively is done, and girls like to see an adequate reward for their labours.

3. Time taken to give out work to set every child going and to collect is longer, perhaps, than in any other lesson; unnecessary time is wasted if this were done four times a week.

4. In teaching a fresh stitch this time admits of the teacher's demonstration lesson, followed by sufficient practice of the class and individual supervision of teacher to allow of the stitch being thoroughly grasped by class while fresh in their minds.

5. In *Upper Standards*, especially, if the class had four lessons per week additional time would be lost from the necessity of more frequently collecting and giving out ink, &c.

12. Should a case of scarlet fever occur, what steps should be taken to prevent the spread of it: (1) to the other members of the family; (2) to the neighbouring inhabitants; and (3) to the succeeding tenant?

(*a*) *Members of Family:*

1. Patient strictly isolated till disease has entirely disappeared. Those in attendance should not be in free communication with others.

2. All evacuations of patient, cups, plates, food, &c., used in sick room, should be disinfected before being brought out of room.

3. Food and waste matters sent from room should be destroyed at once.

4. Clothing, &c., of patient should not be washed with clothing of others of family.

(*b*) *Inhabitants:*

1. No communication between infected house or its inhabitants.

2. No clothes from house sent to common laundry.

3. Patient not allowed to go out or travel in public conveyances till all danger of risk is over; *i. e.*, not till some time after scales have disappeared.

4. Letters, &c., from house disinfected.

(*c*) *Succeeding Tenant:*

1. Room used by patient thoroughly fumigated by burning sulphur. Ceiling and walls washed, &c.

2. Room should remain empty for some time.

3. Wall paper changed.

4. Floors scrubbed and washed with disinfecting fluid.

Female Candidates.

SECOND YEAR.

Arithmetic.

1. Explain what is meant by cancelling. Say in what arithmetical processes it is useful and give examples.

By cancelling is meant dividing two numbers standing in the relation of Numerator and Denominator of a Fraction.

As stated in the definition this is useful in reducing fractions: *e.g.*, Take the fraction $\frac{29\times3\times7\times4}{61\times3\times7\times4}$. Divided into factors we get $\frac{29\times3\times7\times4}{61\times3\times7\times4}$. We see then that these numbers have the common factor $3\times7\times4$. Remove this from both and we get $\frac{29}{61}$ the value of which is precisely the same as that of the fraction as first given.

In proportion it is very useful, *e.g.*

$$\left.\begin{array}{r} \text{As } 15 : 20 \\ 29 : 48 \\ 32 : 12 \end{array}\right\} :: 87 : x$$

$$x = \frac{87\times20\times48\times12}{15\times29\times32} = \frac{29\times3\times5\times4\times3\times16\times3\times2\times2}{5\times3\times29\times16\times2}$$

The following factors are common to both:—29, 3, 5, 16, 2. Removing these we get as the value of x 3², *i.e.* 72.

2. Reduce these fractions to a common denominator, and explain the reason of the process:— $\frac{5}{12}$; $\frac{4}{15}$; $3\frac{7}{10}$; ·17; $\frac{5}{6}$.

L.C.D. = 600

$$\frac{5}{12}\times\frac{50}{50} = \frac{250}{600}$$

$$\frac{4}{15}\times\frac{40}{40} = \frac{160}{600}$$

$$\frac{37}{10}\times\frac{60}{60} = \frac{2220}{600} = 3\frac{420}{600}$$

$$\frac{17}{100}\times\frac{6}{6} = \frac{112}{600} \quad - \quad 10$$

$$\frac{5}{6}\times\frac{100}{100} = \frac{500}{600}$$

Explanation of process:—If I divide a thing into 100 as many parts as before, to have the same fraction as before, I must have 100 times as many of these smaller parts.

Thus to reduce $\frac{5}{12}$ to a fraction with 600 for its denominator since 12 is contained 50 times in 600 I multiplied both Numer. and Denom. by 50.

3. Give, with examples, rules for shortening the following processes:—

(*a*) Multiplying by 99, 25, 246.

(*b*) Squaring a number.

(*c*) Finding the interest on money for years and months at $2\frac{1}{2}$ %.

Answer.—(*a*) Add two ciphers and subtract the multiplicand from the result. *e.g.* $125 \times 99 = 12{,}500 - 125 = 12{,}375$.

To multiply by 25, add two ciphers and divide by 4. *e.g.* $178 \times 25 = \frac{17800}{4} = \underline{4450}$.

To multiply by 246, add three ciphers, then divide by four and subtract four times the given number.

e.g. $978 \times 246 = \frac{978000}{4} - (978 \times 4)$
$= 244500 - 3912 = \underline{240588}$.

(*b*) Divide the given number into two other numbers, viz., one consisting of the whole number except the last digit which must be substituted by a cipher; and the other consisting of the unit number. Then square these numbers separately and add to the sum of their squares, twice the product of the two said numbers.

e.g. Square 87. $87 = 80 + 7$.
Answer $= 80 \times 80 + 7 \times 7 + 2 \times 80 \times 7$.
$= 6400 + 49 + 1120 = 7569$.

(*c*) Reckon 6d. for every £ per annum, and ½d. for every £ per month.

e.g. Interest on £120 10s. for one year = 120½ sixpences = £3 0s. 3d.
Int. on £50 for 5 months = $50 \times 2\frac{1}{2}$d. = 125d. = 10s. 5d.

4. Find the least common multiple of 20, 12, 15, 18, and 4; and the greatest common measure of 702, 1368, 1944.

2) 20, 12, 15, 18, 4
2) 10, 6, 15, 9
3) 5, 3, 15, 9
5, 3

L. C. M. $= 2 \times 2 \times 3 \times 5 \times 3 = \underline{180}$.

$702 = 6 \times 3 \times 13 \times 3$
$1368 = 6 \times 3 \times 2 \times 19 \times 2$
$\underline{1944 = 6 \times 3 \times 3 \times 2 \times 3 \times 3 \times 2}$

The only factors common to all three are 6 and 3 ∴ G. C. M. = 18.

5. By ordering coal direct from the pit owner, I obtain 21 cwt. for each ton. What quantity must I purchase, in order to effect a saving of 15s. when the price of coal is 25s. a ton?

On each ton I purchase, $\frac{1}{20}$ of a ton is as it were returned to me. *i.e.* I have returned $\frac{25s.}{20} = 1s.\ 3d.$ worth of coals.

$\frac{15s.\ 0d.}{1s.\ 3d.} = \frac{15 \times 12}{15} = 12$ = number of tons ordered; but under the circumstances stated above I receive <u>12 tons, 12 cwts.</u>

6. If a reduction of 30 per cent. were made in the price of eggs, it would enable the buyer to obtain 54 more for a guinea. What is the present price?

The price after the reduction would be $\frac{7}{10}$ of a guinea for the same number of eggs as before, *i.e.* $\frac{3}{10}$ of a guinea will be saved, and for this 54 eggs can be bought.

As 3 : 10 :: 54 : 180

i.e. We should then have 180 eggs for 1 guinea.

But by the question, as the prices are, we get only $\frac{7}{10}$ this number, *i.e.* $\frac{180 \times 7}{10} = 126$.

<u>126 eggs for a guinea.</u> Ans.

7. In what proportion should two kinds of tea—the one costing 2s. 6d. and the other 3s. 9d. a pound—be mixed so as to be worth 2s. 9d. per lb.? Prove your answer.

In selling 1 lb. of 3s. 9d. at 2s. 9d. you lose 1s. 0d.
In selling 1 lb. of 2s. 6d. at 2s. 9d. you gain 3d.
Therefore to neither gain nor lose you must sell four of the cheaper to one of the dearer.

Proof $4 \times 2s.\ 6d. = 10s.\ 0d.$
$1 \times 3s.\ 9d. = 3s.\ 9d.$
∴ 5 cost 13s. 9d.
i.e. 1 costs <u>2s. 9d.</u>

8. At 5½ guineas per £100, what sum must be insured on goods worth £813 11s. 3d. so that in case of loss the owner may receive the value of the goods, and of the premium?

As £100 : £813 11s. 3d. :: guineas 5½ = £5 15s. 6d. : Premium on £813 11s. 3d.

20 / 2000 — 20 / 16271
4 / 8000 — 4 / 65085

$\frac{£5\ 15s.\ 6d. \times 65085}{8000} = \underline{£46\ 19s.\ 7\frac{41}{80}d.}$; or approximately <u>£47.</u>

Again as £100 : £47 :: £5 15s. 6d. : Premium on £47

$\frac{£5\ 15s.\ 6d. \times 47}{100} = \underline{£2\ 14s.\ 3{\cdot}42d.}$

Thus the whole premuim = £47 + £2 14s. 3·42d.
= <u>£49 14s. 3d.</u> approximately.

9. The sum of £149 16s. has to be divided among 15 men, 17 women, and 8 children, in such a way that each woman shall receive three times as much as a child, and ½ the share of a man. What will each man, each woman, and each child receive?

Let 1 represent a man's share, then ⅓ represents a woman's, and ⅛ a child's } These fractions reduced to L. C. D. = $\frac{63, 39, 13}{63}$

∴ Man's sh. : Woman's sh. : Child's sh. as 63 : 39 : 13.
The men will have of the whole $15 \times 63 = 945$ parts
,, women ,, ,, $17 \times 39 = 663$,,
,, children ,, ,, $8 \times 13 = 104$,,
The total number of parts = 1712

$\frac{£149\ 16s.}{1712} = 1s.\ 9d.$

∴ Each man will receive 1s. 9d. × 63 = <u>£5 10s. 3d.</u>
,, woman ,, 1s. 9d. × 39 = <u>£3 8s. 3d.</u>
,, child ,, 1s. 9d. × 13 = <u>£1 2s. 9d.</u>

10. What is the difference between the Simple Interest on £1,200 at 6 % for 2½ years; and the Compound Interest on the same sum paid half yearly?

Simple Interest = $\frac{P \times T \times R}{100} = \frac{\overset{12}{\cancel{1200}} \times 2\frac{1}{2} \times 6}{\underset{1}{\cancel{100}}} = £180$.

Compound Interest = $PR^n - P = P(R^n - 1)$ where n = number of periods in which the interest is paid; which in this case is 6 months.

6 % per annum = 3 % per 6 months.
R = 1·03.
$P(R^n - 1) = £1200\ (1{\cdot}03^5 - 1) = £1200\ (1{\cdot}03 \times 1{\cdot}03 \times 1{\cdot}03 \times 1{\cdot}03 \times 1{\cdot}03 \times 1{\cdot}03 - 1)$
$= £1200\ (1{\cdot}1592740743 - 1) = £1200 \times {\cdot}1592740743$
$= £191\ 2s.\ 6{\cdot}9333984d.$
∴ the required difference = £191 2s. 6·9333984d. − £180
= <u>£11 2s. 6·9333984d.</u>

11. Distinguish between True Discount and ordinary trade or Banker's Discount. Find both on £450, due 1½ years hence at 4½ %.

True discount is the difference between the present value of the bill and the amount of it.

Banker's discount is the Simple Interest on the amount of the bill for the given time and rate.

£100 in 1½ years at 4½ % amounts to £106 15s. ∴ £100 is the present value of £106 15s. due 1½ years hence at 4½ %.

As £106 15s. : £450 :: £6 15s. :

$\frac{4}{427}$ $\frac{4}{1800}$

$\frac{£6\ 15s. \times 1800}{427} = \underline{£28\ 9s.\ 1\frac{17}{71}d.}$ True Discount.

$\frac{£450 \times 1\frac{1}{2} \times 4\frac{1}{2}}{100} = \underline{£29\ 5s.\ 0d.}$ Banker's Discount.

12. Two clocks are set right at 12 o'clock. One gains 7 seconds, and the other loses 8 seconds in 12 hours; after what interval will one be half an hour in advance of the other, and what o'clock will each of the two then indicate?

They separate at the rate of 15 seconds in 12 hours

As 15 seconds : 30 min. :: 12 hours : required interval

$\frac{12 \times 30 \times 60}{15} = 1440$ hours $= 60$ days of 24 hrs. each.

In 60 days there are 120 periods of 12 hours each.

In each of these periods the one clock has gained 7 seconds $\therefore$ in the 60 days it has advanced 840 seconds = 14 minutes. The time by the 1st clock will therefore be 14 min. past 12.

The second clock will have lost $120 \times 8 = 960$ seconds = 16 minutes. Therefore the second clock will show 16 min. to 12.

13. When Spanish 4 per cents. are at $63\frac{1}{16}$; Portuguese 3 per cents. at $54\frac{1}{4}$; and Italian 5 per cents. at $99\frac{1}{2}$; which offers the best investment, supposing all to be equally secure? If I invest £1,000 in each of the 3 stocks, what annual dividend shall I receive?

1st. $\frac{£1000}{63\frac{1}{16}} \times 4 = \frac{£1000 \times 4 \times 16}{1009} = \frac{64000}{1009} = \underline{£63\ 8s.\ 6\frac{1006}{1009}d.}$

2nd. $\frac{£1000}{54\frac{1}{4}} \times 3 = \frac{£1000 \times 3 \times 4}{217} = \frac{£12000}{217} = \underline{£55\ 5s.\ 11\frac{133}{217}d.}$

3rd. $\frac{£1000}{99\frac{1}{2}} \times 5 = \frac{£1000 \times 5 \times 2}{199} = \frac{£10000}{199} = \underline{£50\ 5s.\ 0\frac{50}{199}d.}$

These show the respective dividends, from which it is apparent that Spanish 4 per cents. is the best investment.

14. By what fraction of an inch should a mountain $4\frac{1}{2}$ miles high be represented on a globe 18 inches in diameter, assuming the diameter of the Earth to be 7,900 miles.

As 7,900 miles : 18 inches :: $4\frac{1}{2}$ miles : Ans.

$\frac{18 \times 4\frac{1}{2}}{7900}$ inches $= \frac{18 \times 9}{7900 \times 2} = \underline{\frac{81}{15800}}$ inch.

15. Express in words the arithmetical truths embodied in these formulae:—

If a be greater than b, then $\frac{a+1}{b+1}$ is less than $\frac{a}{b}$; but

If a be less than b, then $\frac{a+1}{b+1}$ is greater than $\frac{a}{b}$, but

$\frac{a-1}{b-1}$ is less than $\frac{a}{b}$

and give a demonstration by means of numbers, such as would be helpful to a class in understanding fractions.

Answer.—If the numerator of a fraction exceeds the denominator and each be increased by unity, the value of the fraction is diminished.

But if the numerator be less than the denominator and each be increased by unity the value of the fraction is increased, but if numerator and denominator be diminished by unity the value of the fraction is diminished.

Demonstration.—1st let $a = 6$, $b = 5$, then $\frac{a}{b} = \frac{6}{5} = 1\frac{1}{5}$

increase each by unity; then we have $\frac{6+1}{5+1} = \frac{7}{6} = 1\frac{1}{6}$

$1\frac{1}{5} - 1\frac{1}{6} = \frac{1}{5} - \frac{1}{6} = \frac{6-5}{30} = \frac{1}{30}$

Thus in this case $\frac{a+1}{b+1}$ is less than $\frac{a}{b}$ by $\frac{1}{30}$.

2nd Let $a = 5$, and $b = 6$, then $\frac{a}{b} = \frac{5}{6}$; increase each by unity; then we have $\frac{5+1}{6+1} = \frac{6}{7}$

$\frac{6}{7} - \frac{5}{6} = \frac{36-35}{42} = \frac{1}{42}$

Thus in this case $\frac{a+1}{b+1}$ is greater than $\frac{a}{b}$ by $\frac{1}{42}$.

Now diminish a and b by unity, *i.e.*, $\frac{a-1}{b-1} = \frac{5-1}{6-1} = \frac{4}{5}$

$\frac{5}{6} - \frac{4}{5} = \frac{25-24}{30} = \frac{1}{30}$

Thus $\frac{a-1}{b-1}$ is less than $\frac{a}{b}$ by $\frac{1}{30}$.

Algebra and Mensuration.

Three hours allowed for this paper.

Candidates are not permitted to answer more than NINE questions in Algebra, and TWO in Mensuration.

The *solution* must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

Algebra.

1. Show that a, b, c are in arithmetic, geometric, or harmonic progression, according as

$$\frac{a-b}{b-c} = \frac{a}{a} \text{ or } = \frac{a}{b} \text{ or } \frac{a}{c}.$$

If a, b, c, d are in geometric progression, $(a-d)^2 = (b-c)^2 + (c-a)^2 + (d-b)^2$.

(I.) $\frac{a-b}{b-c} = \frac{a}{a} = 1 \quad \therefore a - b = b - c$

let $a - b = x$, then $b - c = x$

But 'Quantities are said to be in A.P. when they increase or decrease by a common difference,' $\therefore$ a, b, c are in A.P.

(II.) $\frac{a-b}{b-c} = \frac{a}{b}$ then $ab - b^2 = ab - ac$

$\therefore ac = b^2$

and $\therefore \frac{a}{b} = \frac{b}{c}$, and $\frac{b}{a} = \frac{c}{b}$

let $\frac{b}{a} = x$, then $\frac{c}{b} = x$

$\therefore b = ax$ and $c = bx = (ax)x = ax^2$

$\therefore b = ax$ and $c = ax^2$

$\therefore a$, b, c are in G.P.

(III.) $\frac{a-b}{b-c} = \frac{a}{c}$

$\therefore a : c :: a - b : b - c$,

$\therefore a$, b, c are in H.P.

(IV.) Let x be the common ratio, then $b = ax$, $c = ax^2$, $d = ax^3$, and by substitution

$$(a - ax^3)^2 = (ax - ax^2)^2 + (ax^2 - a)^2 + (ax^3 - ax)^2$$

$$a^2 - 2a^2x^3 + a^2x^6 = a^2x^2 - 2a^2x^3 + a^2x^4 + a^2x^4 - 2a^2x^2 + a^2 + a^2x^6 - 2a^2x^4 + a^2x^2$$

$$= a^2 - 2a^2x^3 + a^2x^6$$

Q. E. D.

2. Define ratio, and if

$$\frac{a+c}{b} = \frac{c}{a} = \frac{a}{c-b}$$

determine the ratios $a : b : c$.

If the square root of x varies as the cube root of y, and if $x = 64$ when $y = 343$, find the equation between x and y.

Ratio is the relation which one quantity bears to another with respect to magnitude, the comparison being made by considering what multiple, part, or parts, the first quantity is of the second.

(*b*) By addition of the three antecedents and the three consequents we have

$$\frac{2a+2c}{a+c}=\frac{c}{a}\therefore\frac{2(a+c)}{a+c}=\frac{c}{a}$$

$$\therefore\frac{c}{a}=2\text{ and }c=2a$$

$$\text{again }\frac{a+c}{b}=\frac{2a+2c}{a+c}=2$$

$$\therefore\frac{a+2a}{b}=2,\ \frac{3a}{b}=2$$

$$\text{and } a=\tfrac{2}{3}b,\ b=\tfrac{3}{2}a$$

$$\therefore a:b:c \text{ as } 1:\tfrac{3}{2}:2$$

$$\therefore a:b:c \text{ as } 2:3:4$$

(*c*) $x^{\frac{1}{3}}=my^{\frac{1}{3}}$

$$64^{\frac{1}{3}}=m\,343^{\frac{1}{3}}$$

$$8=7m\ \therefore\ m=\tfrac{8}{7}$$

$$\therefore x^{\frac{1}{3}}=\tfrac{8}{7}y^{\frac{1}{3}}$$

$$\text{and } x=\tfrac{512}{343}y^{\frac{1}{3}}$$

3. Find the number of combinations of (n) different things, taken (r) together.

The number of combinations of (n) things, 3 together, is two-thirds of the number, 5 together; find n.

(a) The number of permutations of (n) things taken (r) together is $n(n-1)(n-2)\ldots\ldots(n-r+1)$; and each combination produces $\lfloor r$ permutations; hence the total number of combinations must be

$$\frac{n(n-1)(n-2)\ldots\ldots(n-r+1)}{\lfloor r}$$

If we multiply both numerator and denominator by $\lfloor n-r$ it becomes $\frac{\lfloor n}{\lfloor r\,\lfloor n-r}$, an expression which is often convenient.

(b) $$\frac{n(n-1)(n-2)}{1.\ 2.\ 3}=\tfrac{2}{5}\cdot\frac{n(n-1)(n-2)(n-3)(n-4)}{1.\ 2.\ 3.\ 4.\ 5}$$

$$1=\tfrac{2}{5}\cdot\frac{(n-3)(n-4)}{4.\ 5}$$

$$1=\frac{n^2-7n+12}{30}$$

$$n^2-7n+12=30$$

$$n^2-7n+\tfrac{49}{4}=30+\tfrac{1}{4}=\tfrac{121}{4}$$

$$n=\tfrac{7}{2}\pm\tfrac{11}{2}=9.\text{ Ans.}$$

4. Show that there are $n+1$ terms in the expansion of $(1+x)^n$, n being a positive integer.

Write down the middle term of $(3a-4x)^8$.

(a) By ordinary multiplication we obtain

$$(1+x)^2=1+2x+x^2$$

$$(1+x)^3=1+3x+3x^2+x^3$$

$$(1+x)^4=1+4x+6x^2+4x^3+x^4$$

$$=1+4x+\frac{4\cdot3}{1.\ 2}x^2+\frac{4\cdot3\cdot2}{1.\ 2.\ 3}x^3+\frac{4\cdot3\cdot2\cdot1}{1.\ 2.\ 3.\ 4}x^4$$

Suppose therefore

$$(1+x)^{(n-1)}=1+(n-1)x+\frac{(n-1)(n-2)}{1.\ 2}x^2\ldots\ldots+x^{n-1}$$

Multiply by $(1+x)$

$$\text{then }(1+x)^n=1+n+x+\frac{n(n-1)}{1.\ 2}x^2\ldots\ldots+x^n$$

Now we have seen that if (n) = 3, there are 4 terms, and if (n) = 4, there are 5 terms: also that if the formula be supposed true for ($n-1$) it holds for (n): and it has been shown to be true when (n) is 4, therefore it holds when (n) is 5, 6, 7, &c. Therefore it holds universally.

(b) Middle term $=\frac{8\cdot7\cdot6\cdot5}{1.\ 2.\ 3.\ 4}(3a)^4(4x)^4$.

5. **Prove that a quadratic equation has two roots and no more.**

If the ratio of the roots of $x^2+px+q=0$ be equal to that of the roots of $x^2+rx+s=0$, then will $p^2:r^2::q:s$.

(a) Any quadratic equation will take the form $ax^2+bx+c=0$, and then the value of x is either

$$\frac{-b+\sqrt{b^2-4ac}}{2a}\text{ or }\frac{-b-\sqrt{b^2-4ac}}{2a}$$

$\therefore$ a quadratic equation has *two* roots.

Again, if possible let there be *three* roots p, q, r of the equation $ax^2+bx+c=0$

Then by supposition $ap^2+bp+c=0$

$$aq^2+bq+c=0$$

$$\text{and } ar^2+br+c=0$$

By subtraction $a(p^2-q^2)+b(p-q)=0$.

Divide by $p-q$ which is, by supposition, not zero; then

$$a(p+q)+b=0$$

Similarly we have $a(p+r)+b=0$

$\therefore$ by subtraction $a(q-r)=0$, which is impossible, since by supposition a is not zero, and $q-r$ is not zero,

$\therefore$ a quadratic equation cannot have *three* different roots.

(b) The roots of $x^2+px+q=0$

$$\text{are }\frac{-p+\sqrt{p^2-4q}}{2}\text{ and }\frac{-p-\sqrt{p^2-4q}}{2}$$

The roots of $x^2+rx+s=0$

$$\text{are }\frac{-r+\sqrt{r^2-4s}}{2}\text{ and }\frac{-r-\sqrt{r^2-4s}}{2}$$

$$\therefore\frac{-p+\sqrt{p^2-4q}}{-p-\sqrt{p^2-4q}}=\frac{-r+\sqrt{r^2-4s}}{-r-\sqrt{r^2-4s}}$$

By an application of proportion;

$$\text{If }\frac{a}{b}=\frac{c}{d}\text{ then }\frac{a+b}{a-b}=\frac{c+d}{c-d}$$

$$\therefore\frac{-2p}{2\sqrt{p^2-4q}}=\frac{-2r}{2\sqrt{r^2-4s}}\text{ and }\frac{-p}{\sqrt{p^2-4q}}=\frac{-r}{\sqrt{r^2-4s}}$$

Square both sides; then

$$\frac{p^2}{p^2-4q}=\frac{r^2}{r^2-4s}$$

$$\therefore\frac{p^2-4q}{p^2}=\frac{r^2-4s}{r^2}$$

Subtract 1 from each side; then

$$\frac{-4q}{p^2}=\frac{-4s}{r^2}$$

$$\therefore\frac{p^2}{r^2}=\frac{-4q}{-4s}=\frac{q}{s}$$

$$\therefore p^2:r^2::q:s.\qquad\text{Q. E. D.}$$

6. What is the rule for writing down the characteristic of the logarithm of any number to the base 10?

Prove that $\log\frac{1}{m}=-\log m$.

Show that $3\log\frac{81}{80}+5\log\frac{25}{24}+7\log\frac{16}{15}=\log 2$.

(a) It we agree that the mantissa shall always be positive, the rule is as follows:—

For any number not less than unity, the characteristic is *one less* than the number of digits; thus

2156	characteristic	3
215·6	,,	2
21·56	,,	1
2·156	,,	0

For any number less than unity count from the decimal point to the *first significant figure*; thus

·2156	characteristic	$\bar{1}$
·02156	,,	$\bar{2}$
·002156	,,	$\bar{3}$
&c., &c.		

(b) Suppose $\log_{10} m = x$ then $10^x = m$

$$\therefore \frac{1}{10^x} = \frac{1}{m} \text{ (and } 10^0 = 1)$$

$$\therefore \frac{1}{10^x} = \frac{10^0}{10^x} = 10^{-x}$$

$$\therefore 10^{-x} = \frac{1}{m}$$

$$\therefore \log \frac{1}{m} = -x = -\log m$$

(c) $\log \frac{81}{80} = 4 \log 3 - (1 + 3 \log 2)$
$\log \frac{25}{24} = 2 (1 - \log 2) - (\log 3 + 3 \log 2)$
$\log \frac{16}{15} = 4 \log 2 - (\log 3 + 1 - \log 2)$
$3 (4 \log 3 - 1 - 3 \log 2) + 5 (2 - 2 \log 2 - \log 3 - 3 \log 2)$
$+ 7 (4 \log 2 - \log 3 - 1 + \log 2) = (12 - 5 - 7) \log 3 +$
$(28 - 9 - 10 - 15 + 7) \log 2 - 3 + 10 - 7 = \underline{\log 2}$. Ans.

7. Find a formula for the present value of a given sum due at the end of a given time at a given rate, (1) at simple, (2) at compound interest.

Let P be the present value, M the amount, D the discount, r the interest of one pound for one year, n the number of years, R ($= 1 + r$) the amount of one pound in one year.

At simple interest:

Since r is the interest of £1 for 1 year.

Pr " £P "

and therefore nPr is the interest of P pounds for n years.

$$\therefore M = P + Pnr$$
$$= P (1 + nr)$$

$$\therefore P = \frac{M}{1 + nr} \text{ and } D = M - P$$

$$\therefore D = \frac{Mnr}{1 + nr}$$

At compound interest:

Since R denotes the amount of one pound in one year.

PR " " P pounds "
PRR " " PR " "
$\therefore PR^2$ " " P " in two years.

Similarly the amount in n years is PR^n

$$\therefore M = PR^n$$

$$\therefore P = \frac{M}{R^n} \text{ and } D = M - P$$

$$\therefore D = \frac{M (R^n - 1)}{R^n}$$

8. Show how any proposed number may be expressed in a given scale of notation.

Transform 4321 from the quinary to the septenary scale.

Let N be the given number, r the radix of the scale in which it is to be expressed. Suppose $p_0, p_1, \ldots p_n$ to be the required digits by which N is expressed in the new scale, beginning with that on the right hand; then

$N = p_n r^n + p_{n-1} r^{n-1} + \ldots + p_2 r^2 + p_1 r^1 + p_0$

Divide N by r, and let Q_1 denote the quotient; then $Q_1 = p_n r^{n-1} + p_{n-1} r^{n-2} + \ldots p_2 r + p_1$ and a *remainder* which is p_0.

Hence p_0 is found by the following rule; '*divide the given number by the proposed radix, and the remainder is the first of the required digits.*'

Again, divide Q_1 by r, and let Q_2 denote the quotient; then $Q_2 = p_n r^{n-2} + p_{n-1} r^{n-3} + \ldots p_2$, and the *remainder* is p_1.

Hence the *second* digit is found. By proceeding in this way we find in succession all the required digits.

7)4321
7)313 + 5
7)21 + 6
1 + 4 1465. Ans.

Or, in this way:—

4 + 3 + 2 + 1
20 115 585
23 117 586
7)586
7)83 + 5
7)11 + 6
1 + 4 1465. Ans.

9. Solve the equations:—

(1) $\sqrt{x^2 + 10x + 5} = \sqrt{5x + 4} + \sqrt{5x - 4}$

(2) $\begin{cases} 4 (x^2 + y^2) = a^2 + 3ab^2 \\ x + y = a \end{cases}$

(a) $\sqrt{x^2 + 10x + 5} = \sqrt{5x + 4} + \sqrt{5x - 4}$
$x^2 + 10x + 5 = 5x + 4 + 5x - 4 + 2\sqrt{25x^2 - 16}$
$x^2 + 5 = 2\sqrt{25x^2 - 16}$
square, then $x^4 + 10x^2 + 25 = 100x^2 - 64$
$x^4 - 90x^2 + 89 = 0$
$x^4 - 90x^2 + (45)^2 = 1936$
$x^2 = 45 \pm 44 = 89$ or 1
$x = \pm\sqrt{89}$ or ± 1. Ans.

(b) $\begin{cases} 4 (x^2 + y^2) = a^2 + 3ab^2 & \text{(I.)} \\ x + y = a & \text{(II.)} \end{cases}$

Divide I. by II.

then $4 (x^2 - xy + y^2) = a^2 + 3b^2$ (III.)

square II. and multiply by 4, then $4 (x^2 + 2xy + y^2) = 4a^2$ (IV.)

subtract (III.) from (IV.) $\therefore 4 (3xy) = 3a^2 - 3b^2$

$$4xy = a^2 - b^2$$

and $(x + y)^2 - 4xy = (x - y)^2$

$$= a^2 - (a^2 - b^2) = b^2$$

$$\therefore (x - y)^2 = b^2 \text{ and } x - y = \pm b$$

and $x + y = a$ (II.)

$$\therefore x = \frac{a \pm b}{2}$$

$$\text{and } y = \frac{a \mp b}{2}$$

Ans.

10. Two passengers have together 600 lbs. of luggage, and are charged for the excess above the weight allowed 3s. 4d. and 11s. 8d. respectively. If all the luggage had belonged to one of them he would have been charged £1. How much luggage is each passenger allowed free of charge?

Let x pounds be the amount free
and $x + p$ be A's luggage
and $x + q$ be B's "
$\therefore 2x + p + q = 600$ lbs.

$$\text{and } \frac{p}{q} = \frac{3s.\ 4d.}{11s.\ 8d.} = \frac{40}{140} = \frac{2}{7}$$

$\therefore$ If A's luggage be $2y$, B's is $7y$.

$$\text{Again } \frac{p}{x + p + q} = \frac{3s.\ 4d.}{20s.\ 0d.} = \frac{40}{140} = \frac{2}{14}$$

$\therefore x + p + q = 12y$
then $2x + 9y = 600$
$x + 12y = 600$
$2x + 24y = 1200$
$15y = 600$
$\therefore y = 40$
$x = 120$ lbs. Ans.

11. For each of five boats a steerer and four oarsmen are required; 25 men are found to go in the boats, but five of them can only steer. In how many ways can the crews be chosen?

It is obvious that there are only 20 rowers, and the number of combinations of 20 things taken 4 together

is $\frac{20.\ 19.\ 18.\ 17}{1.\ 2.\ 3.\ 4}$. This is therefore the number of rowing crews.

Each of these may sit in either of 5 boats, and to each of these arrangements any one of the 5 steerers may be added;

The total number is therefore $\frac{20.\ 19.\ 18.\ 17}{1.\ 2.\ 3.\ 4} \times 5 \times 5$.

Mensuration.

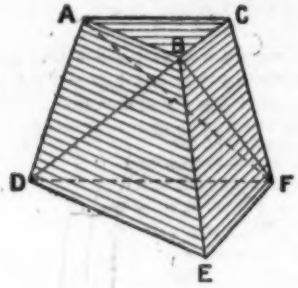
($\pi = 3\frac{1}{7}$.)

1. Prove the following rule for finding the volume of a frustum of a cone.

To the areas of the two ends of the frustum add the square root of their product; multiply the sum by the height of the frustum, and one-third of the product will be the volume.

The circumference at one end of the mast of a ship is 55 inches, and at the other 33 inches. Find the number of cubic feet of wood, the height of the mast being 36 feet.

The volume of the frustum of a triangular pyramid may be found thus:—



Let ABCDEF be the frustum, the plane ABC being parallel to the plane DEF.

Let it be cut by the planes BDF, BAF into *three* pyramids, viz., BDEF, FABC, BADF; and let the areas of ABC, DEF, be b, B, and the height of the frustum h.

Then BDEF $= \frac{1}{3}h$B, and FABC $= \frac{1}{3}hb$; it therefore remains only to express the volume of the pyramid BADF.

Now BADF : BACF :: base ADF : base ACF

:: DF : AC

:: $\sqrt{\text{B}}$: $\sqrt{b}$

And $\therefore$ BADF $= \frac{\sqrt{\text{B}}}{\sqrt{b}} \times$ BACF

$= \frac{\sqrt{\text{B}}}{\sqrt{b}} \cdot \frac{1}{3}hb = \frac{1}{3}h\sqrt{\text{B}b}$

$\therefore$ whole volume of frustum $= \frac{1}{3}h[\text{B} + b + \sqrt{\text{B}b}]$

This formula may be extended to the volumes of the frusta of pyramids in general; and since the *cone* is equal to a pyramid with an infinite number of sides, it holds also for the volume of the frustum of a cone. Q. E. D.

(b) Area of circle $= \pi r^2$

$r = \frac{\text{circum.}}{2\pi}$ $\therefore$ area $= \left(\frac{\text{circum.}}{2\pi}\right)^2 \pi = \frac{\text{circum.}^2}{4\pi}$

$\frac{55^2}{4\pi} = \frac{3025}{4 \times \frac{22}{7}} = \frac{3025}{\frac{88}{7}}$ 88) 21175 (240$\frac{55}{88}$ area of larger end
357
55

$\frac{33^2}{4\pi} = \frac{1089}{\frac{88}{7}}$ 88) 7623 (86$\frac{55}{88}$ area of smaller end
583
55

Product $= 240\frac{5}{8} \times 86\frac{5}{8} = 20844{\cdot}140625$

sq. root	20844·140625 (144·375
24	108
284	1244
2883	10814
28867	216506
288745	1443725

Area of large end	240$\frac{5}{8}$	height	471$\frac{1}{2}$	432
Area of small ,,	86$\frac{5}{8}$		432 (inches)	5
Sq. root of prod. ,,	144$\frac{1}{2}$		3024	8) 2160
	471$\frac{1}{2}$		1728	270
			270	
			3) 203742	
			67914 cubic inches	

1728) 67914 (39·3 cubic feet
16074
5220
36

39·3 cubic feet. Ans.

2. Find the radius of a sphere whose volume is 6558·552 cubic feet.

Vol. $= \frac{4}{3}\pi r^3$ $\therefore$ radius $= \sqrt[3]{\frac{6558{\cdot}552}{\frac{4}{3}\pi\ (= \frac{88}{7})}}$

11) 6558·552
8) 596·232
74·529
21
74·529
1490·58
Cube root 1565·109 = 11·6 +

11·6 feet. Ans.

3. A rectangular parallelopiped of metal, whose edges are 11, 18, and 22 inches, is to be drawn into a wire ·016 of an inch in diameter. Find the length of the wire in miles.

11 × 18 × 22 = 4356 (cubic inches)

·016 $= \frac{16}{1000} \times \frac{3^2}{4} = \frac{3^2 2^2}{4 \times 5^3} = \frac{3^2}{5^3}$ area of section of wire

$\frac{4356}{\frac{3^2}{5^3}} = 4356 \times \frac{5^3}{3^2} = 83160$ inches = length of wire

12) 83160
3) 6930 ft.
5½) 2310 yds.
40) 420 poles
8) 10 20 furlongs
1 2 20

1 mile 2 fur. 20 poles or 1 mile 550 yds. Ans.

Greek.

Male candidates may answer questions in TWO languages.

TWO hours allowed for this paper.

SECTION I.

1. Translate into English:—

(*a.*) Ἐπειδὴ δὲ βοὴ πλείων τε ἐγίγνετο, καὶ οἱ ἀεὶ ἐπιόντες ἔθεον δρόμῳ ἐπ τοὺς ἀεὶ βοῶντας, καὶ πολλῷ μείζων ἐγίγνετο ἡ βοὴ ὅσῳ δὴ πλείους ἐγίγνοντο ἐδοκεῖ δὴ μᾶζόν τι εἶναι τῷ Ξενοφῶντι. Καὶ ἀναβὰς ἐφ' ἵππον καὶ Λύκιον κα τοὺς ἱππέας ἀναλαβὼν παρεβοήθει· καὶ ταχα δὴ ἀκούουσι βοώντων τῶν στρατιωτῶν, θάλαττα, θαλαττα, καὶ παριγγυώντων. Ἔνθα δὴ ἔθεον ἅπαντες καὶ οἱ ὀπισθοφύλακες, καὶ τὰ ὑποζύγια ἠλαύνετο καὶ οἱ ἵπποι. Ἐπεὶ δὲ ἀφίκοντο πάντες ἐπὶ τὸ ἄκρον, ἐνταῦθα δὴ περιέβαλλον ἀλλήλους καὶ στρατηγοὺς καὶ λοχαγοὺς δακρύοντες. Καὶ ἐξαπίνης, ὅτου δὴ παρεγγυήσαντος, οἱ στρατιῶται φέρουσι λίθους καὶ ποιοῦσι κολωνὸν μέγαν. Ἐνταῦθα ἀνετίθεσαν δερμάτων πλῆθος ὠμοβοΐνων καὶ βακτηρίας καὶ τὰ αἰχμάλωτα γέρρα· καὶ ὁ ἡγεμὼν αὐτὸς τε κατέτεμνε τὰ γέρρα καὶ τοῖς ἄλλοις διεκελεύετο.

2. Parse ἐπιόντες, ἠλαύνετο, ἀνετίθεσαν.

3. (*b.*) ΚΡ. δέδοικά σ', οὐδὲν δεῖ παραμτίσχειν λόγους,
μή μοί τι δράσῃς παῖδ' ἀνήκεστον κακόν.
ξυμβάλλεται δὲ πολλὰ τοῦδε δείματος·
σοφὴ πέφυκας καὶ κακῶν πολλῶν ἴδρις,
λυπεῖ δὲ λέκτρων ἀνδρὸς ἐστερημένη·
κλύω δ' ἀπειλεῖν σ', ὡς ἀπαγγέλλουσί μοι,
τὸν δόντα καὶ γήμαντα καὶ γαμουμένην
δράσειν τι· ταῦτ' οὖν πρὶν παθεῖν φυλάξομαι
κρεῖσσον δέ μοι νῦν πρός σ' ἀπεχθέσθαι, γύναι,
ἢ μαλθακισθέντ' ὕστερον μέγα στένειν.

ΜΗ φεῦ φεῦ
οὐ νῦν με πρῶτον, ἀλλὰ πολλάκις, Κρεον,
ἔβλαψε δόξα μεγάλα τ' εἴργασται κακά.
χρὴ δ' οὔποθ' ὅστις ἀρτίφρων πέφυκ' ἀνὴρ
παῖδας περισσῶς ἐκδιδάσκεσθαι σοφούς·
χωρὶς γὰρ ἄλλης ἧς ἔχουσιν ἀργίας
φθόνον πρὸς ἀστῶν ἀλφάνουσι δύσμενῆ.
σκαιοῖσι μὲν γὰρ καινὰ προσφέρων σοφὰ
δόξεις ἀχρεῖος κοὐ σοφὸς πεφυκέναι·
τῶν δ' αὖ δοκούντων εἰδέναι τι ποικίλον
κρείσσων νομισθεὶς λυπρὸς ἐν πόλει φανεῖ.

4. Parse *δείματος, ἀνδρὸς, δρᾶσειν, ἀπεχθέσθαι, ἐκδιδάσκεσθαι.*

Section I.

1. But then the shout became greater, and these continually advancing proceeded with a run towards those who were shouting unceasingly, and the shout became far greater, and as they became more numerous so it seemed to be something more important to Xenophon. And mounting horse and taking with him Lucius and the cavalry he went to the rescue; and very soon they hear the soldiers shouting 'the sea, the sea,' and passing the word along. Just then all ran, as did also the rear-guard; and the beasts of burden, and the horses were driven. But when they all reached the summit, then indeed they embraced one another, and the generals and the captains weeping. And, immediately, having really arrived near it (the sea), the soldiers bring stones and erect a mighty column. There they dedicated a large number of raw ox-hides, and staves, and wicker-work articles, taken as booty, and the leader himself cut down wattles and ordered the others to do likewise.

2.

ἐπίοντες	Present participle of *ἔπειμι*, nominative, masculine, plural, agreeing with *οἱ*.
ἠλαύνετο	3rd, singular, imperfect, indicative, passive of *ἐλαύνω*, agreeing with *ὑποζύγια* (plural form).
ανετίθεσαν	3rd, plural, imperfect, indicative of *ανατιθημι*, agreeing with *οἱ* (understood).

3. *Κρ.*—It is useless to disguise words, I fear thee lest thou do some deadly evil to my child. Many are the things causing this fear; you are naturally wise and experienced in many evils, and thou art grieved at being deprived of the marriage-bed of thy husband. But I hear, as they report to me, that you threaten to do some revengeful deed to him who bestows the bride, and to the bridegroom and bride. Therefore I shall protect myself against these things before suffering them; it is better to be hated by thee now, oh woman, than softened by your words afterwards to lament greatly.

Με.—Alas! alas! not now for the first time, but often has this opinion, oh Creon, injured me and worked me much woe. But it is necessary for a man who is naturally intelligent that his children be never instructed so as to be exceedingly wise. For apart from their other charges of idleness, they incur the fatal envy of their fellow-citizens. For indeed bringing new sciences to the uncouth you will appear useless and not wise; and being judged superior to others who seem to possess some varied knowledge, you will appear offensive in the state.

4.

δείματος	Genitive, singular, neuter, 3rd declension of *δειμα*, governed by *συμβαλλεται*.
ἀνδρὸς	Genitive, singular, masculine of *ανηρ*, 3rd declension, governed by *λεκτρων*.
δρασειν	Future, infinitive, active of *δραω*, governed by *απειλειν*.
ἀπεχθέσθαι	Infinitive, passive, present of *ἀπέχθομαι*, governed by *κρεισσων*.
εκδιδασκεσθαι	Infinitive, passive, present of *εκδιδασκω*, governed by *χρη*.

Section II.

Translate into Greek:

(*a.*) Xenophon having thus spoken, the soldiers encamped on the spot.

(*b.*) Having ordered the Lacedæmonians to go forward, the general departed.

(*c.*) I am ready to go and seize the mountain.

(*d.*) It is difficult to please everybody.

(*e.*) The city has been founded (*κτίζω*) by the Athenians.

(*f.*) Whom should I trust (*πιστεύομαι*) more than you?

(*g.*) They marched on, taking the captive with them as guide.

Section II.

(*a.*) *Ξενοφόντος ταῦτα εἰπαντος, οἱ στράτιῶται ἔνθα ἐκαθήντο.*

(*b.*) *Ὁ στρατηγός, κελεύσας τούς Λακεδαιμόνιους προϊέναι, ἀπήλθε.*

(*c.*) *Θέλω ἔρχεσθαι ὥστε τό ὄρος συλλάμβανειν.*

(*d.*) *Χαλεπον ἐστὶ τό πᾶσιν ἀρέσκειν.*

(*e.*) *ἡ πόλις ἔκτισται ὑπὸ τῶν Αθήναιῶν.*

(*f.*) *Ἐν τίνι δεῖ μέ πιστένειν πλεῖον ἢ ἔν σοι;*

(*g.*) *Ἐπορενοντο, ἀναλαβόντες τόν αἰχμάλωτον ἡγεμόνα.*

Section III.

1. Give some account of Euripides and his works.

Euripides was born at Salamis B.C. 480, his parents having fled from Athens on the invasion of Xerxes. Studied painting, philosophy, literature, and rhetoric. Among his teachers were Prodicus, Anaxagoras, and Socrates. Wrote early, one of his plays was acted 455 B.C. In 441 he gained the 1st prize, and continued to exhibit plays till the publication of Orestes in 408. He was then invited by King Archelaüs to Macedonia, but died two years later, it is said, torn to pieces by dogs through the rivalry of poets. Euripides did not improve on tragedy; indeed in a few particulars he enfeebled it; but his poetry is remarkable for pathos. Eighteen of his tragedies are still extant; among these are *Medea*, 431 B.C.; *Hercules Furens*, 415; *Electra*, 425; *Cyclops* (a satyric drama), *Ion*, and the *Troades*.

2. Remark on any noticeable points of construction in the following passages:—

(*a.*) *ἄλλο τι ἠ οὐδὲν κωλύει παριέναι;*

(*b.*) *ἦν τε εἰς πη δυνηθῇ τῶν λόχων ἐπὶ τὸ ἄκρον*
ἀναβῆναι, οὐδεὶς μηκέτι τείνῃ τῶν πολεμίων.

(*c.*) *περιττεύσουσιν ἡμῶν οἱ πολέμιοι.*

(*d.*) *ὥστ', ἐξὸν αὐτῷ τἄμ' ἐλεῖν βουλεύματα*
γῆς ἐκβαλόντι, τήνδ' ἀφῆκεν ἡμέραν
μεῖναί μ'.

(*a.*) *ἄλλο τι* which means 'anything else?' when followed by *ἤ* is elliptical. *κωλύει* is understood after *τι*.

(*b.*) *μηκέτι* does not occur in the clause governed by *ἦν*; therefore *οὐκέτι* should have been the word used. *οὐδεὶς* and *μηκέτι* should not correctly be in the same clause. *Again*, in the apodosis the optative or indicative with *ἄν* would have been expected rather than the subjunctive.

(*c.*) *περιττευω* generally takes the accusative of the thing and dative of the person. But here the prepositional prefix exerts its own power of governing the genitive case.

(*d.*) After *ἀφῆκεν*, since *μεῖναί* shows purpose, *ὥστε* would have been used in prose.

ἐξὸν is an impersonal participle = 'it being possible,' *αὐτῳ* could have been *αὐτον* for *εξεστι* may take the dative and infinitive as here, or the accusative and the infinitive.

ἐκβαλοντι is used reflexively and does not qualify *αὐτῷ*, but is dative of possession, as though *ἐμοί* instead of *ἐμα* had been used.

3. In what constructions may the following verbs be used:—*ἀκούω, παύσομαι, ἐεῖ, χράομαι, ἀπαντάω, ἄρχειν, φθάνω.*

Illustrate your answer by examples in each case.

ἀκούω	Genitive of person and infinitive; as *ἀκουὲω πάτρος λέγειν.*
παύσομαι	Accusative of person and genitive of thing; as *παυσομαι Ἕκτορα μάχης.*
	Accusative of person and participle; as *παυσομαι τινα ἀριστεύοντα,* to stop a person from being first.
ἐεῖ	Accusative and infinitive; as *ἐεῖ τινα ποιῆσαι,* it behoves a person to do.
	Genitive of thing; as *πολλου ἐεῖ,* there wants much.
χραομαι	Dative case; as *χρῆσθαι ἱματίῳ,* to wear a garment.
ἀπαντάω	Dative case; as *ἀπαντᾷ μοί κραυγὴ,* a shouting reaches me.
ἄρχειν	Genitive case; as *ἀ᾽ρχειν τῆς πληγῆς,* to strike the first blow.
φθάνω	The action in which one outstrips the other is expressed by the participle; as *μιν φθῆ Τηλέμαχος κατόπισθε βαλών,* Telemachus anticipated him in striking.

4. Distinguish between *ἆρα* and *ἄ᾽ρα, ἐε* and *δὴ, τι* and *τί, του* and *τοῦ, εἶμι* and *εἰμι᾽, εἰς* and *εἶς, που* and *πῶν.*

ἆρα	Interrogative particle, used when a negative answer is expected.
ἄ᾽ρα	1st straightway; 2nd for. This word is always enclitic.
ἐε	But, conjunctive particle correlative with *μεν.*
δὴ	Particle of time; now, already. In phrases like *αγε δὴ* = do but come.
τι	Indefinite pronoun, neuter, enclitic.
τί	Interrogative pronoun, neuter; also meaning how? why? &c.
του	Enclitic, genitive of enclitic pronoun *τις.*
τοῦ	Genitive of article *ὁ* and interrogative particle *τίς.*
εἶμι	I will go; but *ἐιμι᾽,* I am.
εἰς	Preposition governing accusative case; but *εἶς* = 2nd, singular, present, indicative of *ἐιμι᾽,* to be, and of *εἶμι,* to go.
που	An enclitic adverb = anywhere, somewhere.
πῶν	Interrogative adverb = where?

5. What are the ordinary rules for Augment and Reduplication?

Give examples and state exceptions.

The *Augment* is usually prefixed to all the Historical Tenses of the Indicative; *i.e.* to the Imperfect, Pluperfect, and Aorist tenses. If the verb begins with a consonant the syllable *ε* is prefixed, but if it begins with a vowel, the initial vowel is lengthened. The Augment is inserted between the preposition and the verb in verbs compounded with prepositions—the final vowel of the preposition being elided.

Present, τύπτω. Imperfect, ετυπτον, ἐτέτυφειν, ἔτυψα.
,, ἀγγελλῶ. ,, ἤγγελλον. ἤγγελκειν, ἤγγειλα.

Reduplication, in verbs beginning with a consonant, consists in repeating the first consonant of the stem with *ε*. As *λελυκα*, I have loosed, from *λύω*, I loose.

In verbs beginning with an aspirate the corresponding tenuis is used; as *τέθυκα* from *θύω.*

In verbs beginning with two consonants, a double consonant, or with *ρ*, the letter *ε* is the only reduplication. Thus *ἑσταλκα* from *στελλω*; *ἐρριφα* from *ριπτω*; but if there is a mute and a liquid, as *γ, ρ*, they are regarded as one consonant only. Thus *γεγραφα* perfect of *γραφω.*

In verbs beginning with a vowel the initial vowel is lengthened as in the augment; as *ἤγγελκα* perfect of *ἀ᾽γγελλω.*

In verbs compounded with prepositions, the reduplication is placed between the preposition and the verb.

6. Give examples to illustrate—

(*a.*) Agreement and government of the relative.

(*b.*) Genitive absolute.

(*c.*) Expression of point and duration of time.

(*d.*) Partitive Genitive.

Answer. (*a.*) *ἔχω ἃ ὁρῶ* = I have what I see; *ἃ* is accusative governed by *ὁρῶ. λέγε μηδὲν ὧν ἐπίστασαι,* say nothing of those things which you know. Here *ὧν* is attracted into the case of its antecedent. *χρῶμαι οἷς ἔχω βιβλίοις.* Here again *οἷς* is attracted into the case governed by *χρῶμαι.*

(*b.*) *δύοντος τοῦ ἡλίου,* while the sun was setting. *τούτων οὐκ ἀφικομένων,* since they had not come.

(*c.*) The *Genitive* is used to express the *time within which* a thing is done; as *νυκτος,* in the night. *τριῶν ἡμερῶν,* within three days.

After a negative the genitive case corresponds to English *for*; *εἰκόσιν ἐτῶν οὐδέποτε ἀπεδήμησα,* for twenty years I never went away.

The *Dative* expresses '*at*' or '*on*' with regard to time; as *ἐκείνῃ τῇ νυκτι᾽,* on that night.

Duration of time is expressed by the Accusative case; as *τρεῖς ἡμέρας ἐνόσουν,* I was ill for three days.

(*d.*) *οἱ δύο αἰτῶν,* two of them. *δός μοι τοῦ ὕδατος,* give me (some) of the water.

Helps to the Study of Shakespeare's 'Hamlet.'

IN the first of these papers a suggestion was made that, after a careful reading of the play, students should write out a narrative of the incidents, so as to get a clear and connected view of the plot, and a promise was added that this exercise should be exemplified. This promise we now proceed to fulfil.

The play opens at Elsinore on a platform of the castle, with a single soldier, Francisco, on guard. Bernardo, an officer, just upon midnight comes to relieve him, and, after a few words of greeting have been exchanged, Bernardo is joined by Horatio and Marcellus, another officer, and Francisco leaves them. They speak of an apparition which has been seen on previous nights, but about which Horatio is rather sceptical. While Bernardo is detailing the circumstances of its last appearance, it comes again and is recognised by all as having the form of the late King of Denmark. Horatio, as a scholar, is asked to speak to it, and he does so, and the Ghost quickly disappears. Unable to doubt this evidence of his

eyes, Horatio concludes that this occurrence 'bodes some strange eruption to the State,' and especially so when it is coupled with the active warlike preparations that are going on as if to defend the land against a dreaded invasion. As he is recalling what strange and preternatural appearances preceded the fall of Julius Cæsar the Ghost re-enters, and he adjures it to speak to him. But the cock crows, and the Ghost disappears. After commenting on this disappearance, Horatio suggests that young Hamlet be apprised of the events of the night, and, with the first sign of daybreak, the friends leave the scene.

The next scene is a room of state in the castle, and there are assembled the King, Queen, Hamlet, Polonius, Laertes, and other courtiers and attendants. The King Claudius, commenting on the death of Hamlet, the late King, and the consequent grief of the nation, lets us know that the King was his brother, and that he himself has married the King's widow. He recounts the proceedings which have led up to the anticipated invasion of the country by Fortinbras, nephew of the King of Norway, and sends Cornelius and Voltimand, two courtiers, with papers, calling upon the King of Norway to check his nephew's purpose. Turning then to Laertes, son of Polonius, his lord chamberlain, he learns the young man's desire to return to France, whence he had come for the King's coronation (and probably for the late King's funeral), and, after ascertaining that Polonius approves, he grants his permission. Next the King turns to Hamlet, the Prince, and observes his persistent sorrow for his father. The Queen joins in remonstrances against her son's giving way to grief, and both deprecate his contemplated return as a student to Wittenberg. He submits to their wish in this matter, and the King expresses his gratification; but when all the rest have gone out, Hamlet shows in a remarkable soliloquy how far he is from abandoning his grief for his lost father, and how indignant he is at the thought of the speedy marriage of his mother with a man so far inferior to her first husband. As Hamlet closes this soliloquy Horatio, Marcellus and Bernardo enter, and after exchanging greetings and some references to the recent marriage of the Queen, Horatio reports the appearance of the Ghost. Hamlet listens attentively, asks several questions, and expresses his determination to watch with his friends 'this night.' In a few words, when they have withdrawn, he utters his first suspicions of foul play.

The next scene is a room in Polonius' house, where Laertes takes farewell of his sister Ophelia, and, in doing so, warns her not to attach importance to Hamlet's attentions. She promises to heed the lesson, and in return speaks words of caution to her brother. Polonius enters and gives some parting advice to his son in a string of sage maxims. Then learning the subject of Laertes' parting counsel to Ophelia he follows it up with more bluntness, and forbids his daughter to listen any more to Prince Hamlet.

Next, we find Hamlet, Horatio, and Marcellus watching on the platform, near the hour of midnight. The sound of revelry draws from Hamlet some reflections on the national evil of intemperance, and then the Ghost appears, and the Prince, much moved, addresses and follows it, despite the fears and opposition of his friends. On a more remote part of the platform Hamlet holds converse with the Ghost, and by a remarkable narrative of the way in which his father was murdered by his uncle, the present King, is incited to avenge the crime. Horatio and Marcellus, not having been present at this interview, ask some questions about it, in reply to which, however, Hamlet gives only partial information; still he warns them to tell no one of what has happened, and shows that he contemplates assuming the appearance of madness—'an antic disposition.'

The second act opens in the house of Polonius, who instructs his servant Reynaldo to go to Paris to play the spy upon Laertes. As Reynaldo takes his leave Ophelia, in evident alarm, enters, and tells her father of the agitation and seemingly mad behaviour of Hamlet. Polonius at once attributes this to disappointment in his love for Ophelia.

In the next scene the King and Queen, concerned at the change in Hamlet, which they attribute to overmastering grief for his father, instruct two courtiers, Rosencrantz and Guildenstern, to find out, by associating with the Prince, what is really the matter with him. As soon as they have left, Polonius comes in, reports the return of the ambassadors from Norway with good news, and also that he has found the very cause of Hamlet's lunacy. Voltimand and Cornelius make a welcome statement to the effect that Fortinbras, having been rebuked by the King of Norway, has promised never to bear arms against the King of Denmark. Then Polonius unfolds his discovery that Hamlet is mad for love—hopeless love of Ophelia, and undertakes to put his opinion to the proof by contriving a meeting of the two lovers, when they shall be secretly observed. Immediately afterwards, the King and Queen leave Polonius, and Hamlet chances to enter, reading a book. His remarks in conversation serve to confirm Polonius in his opinion. Rosencrantz and Gildenstern then come in and try their arts, of which however Hamlet shows himself suspicious. In the course of the interview they report the arrival of a company of actors to amuse the court. This report is soon confirmed by Polonius, and then the players come in and receive from Hamlet a welcome, with compliments and advice. He talks to them about a play he had heard during a previous visit, quotes and listens to some passages, and then asks the leader of the company if they could play the Murder of Gonzago, and also if he could interpolate a short speech which Hamlet would write. Hamlet left alone pronounces another soliloquy in which he upbraids himself for want of resolution in the matter of his revenge, and hints at the meaning of his question about an additional speech by concluding with the words:—'The play's the thing, Wherein I'll catch the conscience of the King.'

The third act begins with the King and Queen questioning the courtiers as to the result of their watching Hamlet, and urging them to renew their efforts. It is then arranged that the stratagem of Polonius shall be carried out, Ophelia being left in the way of the Prince, while the King and Polonius withdraw and watch. Hamlet in another soliloquy is dwelling on the troubles of life, the dread of death, and other deep problems, when he observes Ophelia. Greeting her respectfully, he soon speaks to her in a fashion strangely unkind and cynical, bidding her 'go to a nunnery.' On his leaving her, Ophelia is

convinced of his madness and greatly distressed by the knowledge. But the King thinks he is not mad for love, that he suffers from melancholy rather than madness, and fearing danger resolves to send Hamlet to England. Polonius, however, advises that the Queen shall 'entreat him alone to show his grief,' while he himself shall secretly listen to the conference, and the King agrees to try this plan before sending him to England.

In the next scene Hamlet gives advice to the players assembled in a hall of the castle as to the speech he would have inserted, and on other points in their acting. He dismisses the players to prepare for their performance. Polonius and the two courtiers who have been set to watch him enter, and Hamlet ascertains from them that the King and Queen will witness the play, and then bids them go and hasten the players. Horatio enters, and Hamlet, after expressing high appreciation of his genuine friendship, tells him of the trap in which he expects to catch his uncle. The royal party then come in and place themselves to see the play, Hamlet making eccentric and cynical remarks in conversation with one and another, but chiefly with Ophelia. The performance begins with a piece of dumb show which, as Ophelia guesses, foreshadows 'the argument of the play,' and very closely images Hamlet's suspicions. After a short prologue the play proceeds, and as the plot is developed Hamlet makes comments upon it to the King and Queen and Ophelia, until the moment when Lucianus, nephew to the player-King, pours poison into his uncle's ear. The King Claudius, beholding this, rises in terror, the play is suddenly stopped, and all leave the hall but Hamlet and Horatio, who speak of this incident and its bearing on the Ghost's narrative. Rosencrantz and Guildenstern come with a message from the Queen, who wishes to see Hamlet privately. Hamlet answers them strangely, but when the players enter with recorders, or flageolets, he shows by a striking illustration how he understands their purpose and despises it. Polonius comes to urge the Queen's request, and is treated with little courtesy and dismissed. Hamlet left alone expresses his intention to speak plainly to his mother, but not unnaturally—to 'speak daggers to her, but use none.'

In the beginning of the following scene the King, in order to free himself from the dread he feels from his nephew's presence at the court, arranges with Rosencrantz and Guildenstern to accompany Hamlet to England. Polonius then informs the King that Hamlet is going to a private interview with the Queen, that he will secretly hear what passes and report it to the King. Left alone, the King soliloquizes on the wicked course by which he has attained his crown and queen, and then kneels in prayer. At this moment Hamlet enters, and contemplates this chance of killing the King and so avenging his father's death; but he refrains, on the ground that, being slain in the act of repentance and prayer, the King would go to heaven, and so meet reward and not punishment. So he proceeds to visit his mother.

In the next scene he finds her just as Polonius has withdrawn behind the tapestry hangings, after instructing the Queen how to deal with her son. As Hamlet at once turns the attack upon his mother—speaking daggers—she is afraid of him, and calls for help. Polonius in his hiding place echoes the cry, Hamlet stabs him through the arras, and the lord chamberlain dies. Then the Prince rebukes his mother for her sin, discovers whom he has slain, and shows in a sentence,—'I took thee for thy better'—that he thought it was the King who had been lurking there. While he is contrasting the character of his uncle with that of his father, the Ghost appears to him, though unseen by the Queen, and his conversation with the spirit is interpreted by her as fresh proof of her son's madness. After the Ghost has gone Hamlet warns his mother to repent of her wrong-doing, and not to let the idea that he is mad be an excuse for not attempting to give up its fruits. He induces her to keep his conversation from the King, then reminds her that he must leave for England with the two courtiers, reveals his knowledge of plots against him, and expresses his determination to circumvent them.

The fourth act opens in the same room with the King questioning the Queen on her interview with Hamlet. She tells him he is mad, and that he has slain Polonius, and that he is now sorry for it. The King sends Rosencrantz and Guildenstern to find Hamlet, and remove the body of Polonius. He further says to the Queen that this matter shall be made known, in the hope that slander may be diverted from himself. The two courtiers find Hamlet and are received by him in very strange fashion. He consents however to go with them to the King. Finding the latter in another room, Rosencrantz reports their failure to find the body, and then Hamlet is brought. With remarks as of a person crazy, Hamlet at last indicates where the body of Polonius may be found, and while attendants are sent to find it, the King announces to Hamlet that he must at once sail for England for the sake of safety. The Prince goes out, followed by the two courtiers, and when alone the King speaks of the purport of the secret orders sent to secure Hamlet's death when he reaches England.

In the next scene we find Horatio reporting to the Queen the distressing grief of Ophelia for her father's death. The Queen reluctantly consents to see her, and Ophelia, in snatches of song, and incoherent speeches, proves herself insane. She goes out, and Horatio is sent to watch her carefully, and while the King is lamenting her state, and the troubles that threaten his own safety, Laertes, whose return he has mentioned, is reported to be heading a riotous band, who proclaim him king. Immediately upon this the doors are burst open, and Laertes enters armed, with a following of Danes. He keeps these outside the door, and asks the King to give him his father. The King reasons with him, and endeavours to guide his avowed purpose of revenge. Ophelia re-enters, and her sad strange sayings serve but to stimulate her brother's purpose, and render the King more ready to make common cause with him.

In another scene sailors bring to Horatio a letter, which proves to be from Hamlet, and relates how the ship in which he set sail for England was attacked by pirates, how he boarded the pirate vessel, and became the only prisoner, his two companions having held their course for England.

The following scene presents an interview between the King and Laertes, and while the former is dwelling on Hamlet, and giving reasons for not proceeding

against his alleged misdeeds, and the latter is nursing the spirit of revenge, a messenger announces letters from Hamlet. The King is startled as he finds his nephew purposes calling on him on the morrow, and Laertes welcomes the prospect of meeting the man who killed his father. Then the King suggests that he will contrive a means by which Hamlet shall surely fall, and that his death shall be only regarded as accident. Laertes accepts the suggestion, provided that he may be the instrument of Hamlet's death. The King unfolds his plan, and shows Laertes how he may have his revenge in a fencing match, in which it shall be arranged that he may use an unblunted rapier. This suggestion Laertes readily accepts, and further says he will make sure of his end by anointing his sword-point with poison. The King further develops the plot by undertaking to have a poisoned drink ready for Hamlet in case he should escape the poisoned weapon. At this point the Queen comes in, and reports that Ophelia is drowned. Clambering in her madness on a willow which grew across a brook, to hang there garlands of flowers, she has fallen into the stream through the breaking of a branch. This announcement again moves Laertes to anger, and as he goes out the King follows him, fearing that the rage he has had so much trouble to allay may be roused afresh against him.

The fifth act opens in a churchyard, where two grave-diggers in clownish fashion make odd arguments and jokes about their occupation. While they are thus engaged Hamlet and Horatio appear, and after the former has uttered some reflections on the workmen and their work he enters into conversation with one of them. Soon a funeral procession approaches. It is attended by the King and Queen and courtiers. Observing that the funeral lacks some of the usual ceremonies Hamlet concludes that a suicide is being buried. Laertes complains of the curtailed rites to the priest, who answers that more has been done than is usual in such a case of doubtful death. Hamlet discovers that it is the fair Ophelia. The Queen strews flowers on the grave, and says it had been her hope to see Ophelia Hamlet's wife. This seems to arouse the rage of Laertes, who jumps into the grave, raving with grief. Hamlet comes up, declares who he is, and also jumps into the grave. Laertes grapples with him. The King calls upon the attendants to part them, and this is done. But Hamlet declaring his supreme love for Ophelia says he will fight her brother on this theme, and so plays into the hands of the King.

The next scene begins with Hamlet relating to Horatio how, when bound for England, he had got up in the night, and, moved by some suspicion, had possessed himself of the packet of instructions of his two companions. There he found that it was intended that he should be put to death. Then he wrote a new commission to the effect that the bearers should be put to death, sealed it with his father's signet, which he happened to have, and placed it safely where he had found the other. The sea-fight followed, and he had escaped. He then defends his action against Rosencrantz and Guildenstern, on the ground that they willingly lent themselves to evil deeds. He speaks of his relations with the King, and expresses regret for having offended Laertes. On this Osric, a courtier, comes, and with many fine phrases of affectation, in which Hamlet mimics him, brings a challenge from Laertes to a trial of skill in fence. The King has wagered six Barbary horses against Laertes. Hamlet undertakes to do his best to win for him. Another lord comes to ask for an immediate answer, and to convey the Queen's desire that Hamlet will be friendly with Laertes before he begins the fencing match. When the messenger has gone with Hamlet's consent, Horatio says Hamlet will lose, and suggests that he might bear an excuse; but Hamlet 'defies augury.'

When the King, Queen and courtiers have assembled to see the match, Hamlet begs Laertes' pardon for the wrong he has done him, pleading his madness as the cause. Laertes, without abandoning his thought of revenge, receives the apology meanwhile, and promises not to wrong Hamlet. They choose their weapons and prepare to play. The King has wine set on the table, drinks to Hamlet, and the play begins. Hamlet gives a hit; the King, putting, as he says, a pearl into the cup, offers Hamlet wine, which Hamlet declines for the time. Again he gives a hit, as Laertes admits. The Queen drinks to her son; the King tries to prevent her but fails and remarks aside, 'it is the poisoned cup.' Laertes apparently hesitates to take a chance to hit Hamlet, who utters words that spur him on. He wounds Hamlet, a scuffle takes place, weapons are exchanged, and Hamlet wounds Laertes. The Queen falls. Laertes admits that he is killed by his own treachery. The Queen realises that she is poisoned, Laertes, falling, reveals the plot, and Hamlet, hearing, stabs the King with the poisoned sword, and endeavours to make him drink from the poisoned cup. Then comes the death of the King, and after a few words of reconciliation with Hamlet, Laertes also dies. While Hamlet is saying last words to his friend Horatio, martial sounds are heard, and Osric reports that young Fortinbras has returned victorious from Poland and is welcoming the English ambassadors. Hamlet gives his 'dying voice' for the election of Fortinbras to the vacant throne. The ambassadors report that the King's command has been obeyed, Rosencrantz and Guildenstern are dead. Horatio undertakes to make known to the people 'how these things came about.' Fortinbras accepts his position as the new king, and orders that Hamlet shall be buried with all military honours; and thus the tragedy closes.

(To be continued.)

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TRANSLATED BY A. M. BOWER, F.R.G.S.,

Late Master in University College School, London.

CHRISTOPHE COLOMB. CHRISTOPHER COLUMBUS.

PREMIÈRE PARTIE. FIRST PART.

CHAPTER II.

Colomb, dans sa pensée,	Columbus, in his thoughts,
aspirait à completer le globe.	aspired to complete the world,
qui lui paraissait	which appeared to him
manquer d'une de ses moitiés.	to want one of its halves.
C'était le besoin	It was the need (want)
de l'unité geographique terrestre	of a terrestrial geographical unity
dont il était travaillé.	with-which he was tormented.
Ce besoin était	This need was
également une inspiration	equally an inspiration
de son époque.	of his age (time).
Il y a des idées	There are ideas
qui flottent dans l'air	which float in the air
comme des miasmes intellectuels,	like intellectual miasms,
et que des milliers d'hommes	and which thousands of men
semblent respirer	seem to breath (inhale)
en même temps.	at the same time.
Chaque fois	Each (every) time
que la Providence	that Providence
prépare le monde,	prepares the world,
à son insu,	unknown to itself,
à quelque transformation religieuse,	for some change, religious,
morale ou politique,	moral or political,
on peut observer	we may observe
presque régulièrement	almost regularly
ce même phénomène :	this same phenomenon :
une aspiration et une tendance	an aspiration and a tendency
plus ou moins complète	more or less complete
à l'unité du globe	to the unity of the world
par la conquête,	by conquest,
par la langue,	by language,
par le prosélytisme religieux,	by religious proselytism,
par la navigation,	by navigation,
par les découvertes géographiques,	by geographical discoveries,
ou par la multiplication	or by the multiplication (growth)
des relations des peuples	of the relations of nations
entre eux,	among themselves,
au moyen du rapprochement	by means of the bringing together
et du contact de ces peuples,	and contact of these nations,
que des voies de communication,	whom means of communication,
des besoins et des échanges	wants and interchanges
resserrent en un seul peuple.	bind together into one people.
Cette tendance	This tendency
à l'unité du globe,	towards the unity of the world,
à certaines époques,	at certain periods,
est un des faits providentiels	is one of the providential facts
les plus visibles	the most (clearly) visible
dans les résultats	in its results
de l'histoire.	in history.
Ainsi,	Thus
quand la grande civilization orientale	when the great Eastern civilization
des Indes et de l'Égypte	of India and of Egypt
semble épuisée de vieillesse,	seems exhausted by age,
et que Dieu veut appeler	and when (que) God wishes to call
l'Asie et l'Occident	Asia and the West
à une civilization plus jeune,	to a younger civilization,
plus mouvante et plus active,	more stirring and more active,
Alexandre part,	Alexander sets out,
sans savoir pourquoi,	without knowing why,
des vallées de la Macédoine,	from the valleys of Macedonia,
entraînant les regards	attracting the notice
et les auxiliaires de la Grèce,	and the auxiliaries (support) of Greece,
et le monde connu devient un,	and the (then) known world becomes one,
sous la terreur et	under the dread (terror) and
sous la gloire de son nom,	glory of his name,
depuis l'Indus	from the Indus
jusqu'à l'extrémité	to the extremity
de l'Europe.	of Europe.
Quand il veut préparer	When He desires to prepare
un auditoire immense	a vast audience
au Verbe transformateur	for the regenerating Word
du Christianisme en Orient	of Christianity in the East
et en Occident,	and West,
il répand la langue,	He extends the language,
la domination, les armes	the rule, the conquests
de Rome et de César,	of Rome and of Cæsar,
des bords du golfe Persique	from the borders of the Persian Gulf
aux montagnes de l'Écosse,	to the mountains of Scotland,
unissant sous un seul esprit	uniting under one form of thought
et sous une seule servitude	and under one bondage
l'Italie, les Gaules,	Italy, the Gauls (countries),
la Grande-Bretagne, la Sicile,	Great Britain, Sicily,
la Grèce, l'Afrique et l'Asie.	Greece, Africa and Asia.
Quand il veut,	When he wishes,
quelques siècles après,	some centuries afterwards,
arracher l'Arabie, la Perse,	to snatch Arabia, Persia,
et leurs dépendances	and their dependencies
à la barbarie,	from barbarism,
et faire prévaloir	and to bring about the triumph of
le dogme irrésistible	the irresistible doctrine
de l'unité de Dieu	of the unity of God
sur les idolâtries	over the idolatry
et sur les indifférences	and (over) the coldness
de ces parties reculées ou corrompues	of these distant or corrupt parts
du monde,	of the world,
il arme Mahomet	He arms Mahomet
du Coran et du glaive ;	with the Koran and the sword ;
il permet à l'islamisme	He permits Islamism
de conquérir en deux siècles	to conquer in two centuries
tout l'espace conquis	all the country conquered
entre l'Oxus et le Tage,	between the Oxus and the Tagus,
entre le Thibet et le Liban,	between Thibet and Lebanus,
entre l'Atlas et le Taurus.	between Atlas and Taurus.
Une immense unité d'empire	One immense unity of Empire
répond d'avance	corresponds in advance
à une immense unité d'idée.	to an immense unity of plan.
Ainsi	Thus (it was)
de Charlemagne en Occident,	with Charlemagne in the West,
quand sa monarchie universelle,	when his universal rule

des deux côtés des Alpes,	on both sides of the Alps,
prépare,	prepares,
depuis la Scythie et la Germanie,	from Scythia and Germany,
le vaste lit où	the vast bed where
la civilization chrétienne	Christian civilization
va recevoir et	is going to receive and
baptiser les barbares.	to baptize the heathen.

Notes.

CHAPTER I.

Verbs of doubting and denying, used negatively or interrogatively, require *ne* before the following verb. *Aucun—ne* = no. *Providence, nom,* &c., nouns in apposition omit the article. *En* takes present participles in *ant* after it. All other prepositions take infinitive. *Ne pas* stand before infinitives. Se joue *de*—comme *de*—, prepositions must be repeated before each noun and pronoun. *Se daigne se servir ; daigner* is one of about 35 verbs which require *no* prepositions before the next *infinitive*. *Dont*—la source = whose—source or the source—of which. *Dont* stands at the head of the sentence, and its noun stands after the verb. Elle *semble* venir ; *sembler* requires no preposition before infinitive. *Il ne s'acquiert pas ;* lit., it does not acquire itself. The reflective or pronominal form is of far more common use in French than in English. Wheat is sold = Wheat sells itself = le blé se vend. *Sans que l'homme puisse ;* lit., without that the man be able = without the man being able. Quelque chose *de* fatal. Something (*of*) fatal. Quoi (rien, quelque chose) de plus beau = what, nothing, something (of) more beautiful ; *de* must be used after the above words. Translate into French : No nation has ever denied that its people were the bravest in the world. The results seem to be satisfactory. Deign to answer me. The Russian language is not easily acquired. Use these men (= make—use of these men) to accomplish your plans. [*All sentences for translation are taken from passages in Christopher Columbus.*]

Grammatical Questions.

CHAPTER I.

1. State which places the pronouns (subject—object) may take in a sentence.

2. Translate : Human things, great things, no human things, no great things.

3. Account for the agreement of the past participle in the sentence : Aucun homme sensé . . . un plan.

4. Why do you put toute-puissante and not tout-puissante. Translate : Some quite new poems. Whilst blowing his hands quite red with cold. In the countries of the north there are quite white and quite black wolves. This lady, however (use tout) elegantly she may be dressed, has no distinguished manners.

5. What is the difference between dessein and dessin ?

6. How would you translate 'faire' before an infinitive ?

7. (*a*) Account for the subjunctive in the sentence, Aucun homme, &c. (*b*) Give the conjunctions after which this mood must always be placed ?

8. 'Œil.' Give the two plurals with their meanings.

9. 'Secrètement.' How do you form adverbs from adjectives ? Give the adverbs of poli, sage, aveugle, fou, franc, gentil, constant, véhément, commun ?

10. Give the feminine of the following adjectives : religieux, paternel, absolu, occulte, ancien.

11. What is the difference in the use of 'connaître' and 'savoir ?' Translate : Not only am I familiar (to know) with Burns' poems, but I know many of them by heart. Do you know where the post-office is ? I know your brother very well.

12. 'Aucun' homme . . . What other indefinite numerals take 'ne' before the verb ?

13. 'Instrument.' Of what gender are the nouns ending in 'ment ?' Why ? Which is the only exception ?

14. Give the infinitive, the present indicative, future, imperfect subjunctive and past participle of 'puisse,' envoie, connu, suit, decouverte, resserrent.

(To be continued).

The Musical Instrument (Violin) Maker of Cremona.

PERSONNAGES.	PERSONS.
Taddeo Ferrari *(master violin maker)*	Thiron.
Filippo *(his pupil)* ...	... Coquelin.
Sandro („) ...	... Laroche.
Giannina *(daughter of Taddeo)* .	Mdlle. Blanche Baretta.

At Cremona towards 1750.

Un atelier de lutherie	A workshop of a musical instrument (violin) maker
au XVIIIe siècle.	in the 18th century.
Au fond, une vitrine	At the back of the stage, a glass partition
avec une grande porte s'ouvrant	with a large door opening
sur une rue de la ville,	into a street of the town
dont on aperçoit les maisons.	the houses of which are to be noticed.
Des violons, des violoncelles, des basses	Violins, violoncellos, bass-viols
et d'autres instruments de musique	and other musical instruments
sont épars dans l'atelier.	are littered about the shop.
A gauche, un comptoir, bien en vue.	At the left a counter, well in view.
A droite, un grand fauteuil près d'une table.	On the right a great arm-chair near a table.
Au fond à droite, un pupitre.	At the back of the stage a desk on the right.
Deux portes latérales.	Two side doors.

Scène Première. Maître Ferrari, Giannina.	First Scene. Master Ferrari, Giannina.
Maître Ferrari, légèrement pris de vin.	*Master Ferrari*, slightly intoxicated with wine.
Non, Giannina, j'ai fait un serment	No, Giannina, I have given the word
d'honnête homme	of a gentleman
Et je veux le tenir.	And I shall keep it.
Aussi vrai qu'on me nomme	As truly as I am called
Taddeo Ferrari, maître et patron luthier	Taddeo Ferrari, master and patron of musical instrument makers
A Crémone et syndic des gens de mon métier	Of Cremona and syndic of the people of my trade
Dont aux processions je porte la bannière,	Whose banner I carry in the processions,
Tu seras mariée et de cette manière.....	Thou shalt be married, and and in this way.....
Giannina.	
Mais, mon père	But, father . . .
Master Ferrari.	
J'agis très raisonnablement.	I act very reasonably.
Notre vieux podestat, décédé récemment,—	Our old podesta who died recently,—
Que Jésus le reçoive en ses miséricordes !—	May Jesus receive him in his mercy !—
Voulant que le renom des instruments à cordes	Wishing that the fame of the string instruments
Sortis de notre vieille et fameuse cité	Which come from our old and famous city
Reste dans l'avenir toujours plus mérité,	Should in future continue to increase in merit,
Vient de léguer sa chaîne en or à l'homme habile	Has bequeathed his golden chain to that clever man

Qui ferait le meilleur violon de la ville.	Who should make the best violin in the town.
Le concours est ouvert et se juge aujourd'hui	The competition is open and is judged to-day.
Et moi, simple artisan, mais m'inspirant de lui,	And I, a simple artisan, but taking my inspiration from him,
Aux compagnons luthiers assemblés en famille	To the companions in trade assembled with their families
J'ai promis de donner ma maison et ma fille	I have promised to give my house and my daughter
A celui qui, par son talent dans notre état	To him who, through his talent in our craft,
Aurait la chaîne d'or du défunt podestat.	Shall have the golden chain of our late podesta.
C'est convenu, conclu, réglé ! Donc, point d'affaire !	It is agreed upon, concluded, settled ! Therefore an end of that !

Giannina.

Je vous ai dit que j'ai quelqu'un que je préfère.	I told you that there is one whom I prefer.

Master Ferrari.

Sandro ! Tu l'oubliras. Le voilà prévenu.	Sandro ! You will forget him. There, he is forewarned.

Giannina.

Mais enfin, si c'était, cet artist inconnu	But then, if this unknown artist were
Un méchant gars et point digne de vous, en somme.	A miserable fellow, and in short unworthy of you.

Master Ferrari.

Un habile ouvrier est toujours honnête homme.	A clever workman is always an honest man.

Giannina.

...Un paresseux, n'ayant de l'avenir nuls soins.	...An idle fellow, without cares for the future.

Master Ferrari.

Etant payé plus cher, il peut travailler moins.	Being better paid he may work less.

Giannina.

...Un brutal qui battrait les femmes ? Il s'en trouve.	...A brute who would ill-treat women ! There are men of this kind.

Master Ferrari.

S'il n'a pas le repos au logis, je l'approuve.	If he has no quiet at home, I approve of it.

Giannina.

...Un buveur, par le vin le dimanche alourdi ?	...A drunkard made heavy by the wine on Sunday ?

Master Ferrari.

Et comment suis-je donc, ma fille, le lundi ?	And how then, am I, my daughter, on Monday ?
Respect aux amateurs des vendanges d'octobre !	Honour to the lovers of the October vintage !
Un bon musicien ne doit pas être sobre.	A good musician must not be sober.
On ne fait pas mentir un dicton. C'est très-mal.	One must not give the lie to a popular saying. It is very bad taste.

Giannina.

Mais enfin, si c'était un tel original	But then, if he were so eccentric
Qu'il refusât ma main ?...Ah !	As to refuse my hand ?...Ah !

(To be continued.)

Recent Inspection Questions.

Arithmetic.

Standard I.

A.

1. Add 79, 306, 572, 4, 476. 1437. Ans.
2. From 198 take 99. 99. Ans.
3. From 909 take 376. 533. Ans.

B.

1. 695 + 35 + 770 + 17 + 309. 1,826. Ans.
2. 703 — 65. 638. Ans.
3. 565 — 491. 74. Ans.

Standard II.

A.

1. Add 87 ; 9,099 ; 9 ; 8,010. 17,205. Ans.
2. 87,509 ÷ 9. $9{,}723\frac{2}{9}$. Ans.
3. 67,098 × 906. 60,790,788. Ans.

B.

1. 90,808 — 999. 89,809. Ans.
2. 95,090 ÷ 12. $7{,}924\frac{2}{12}$. Ans.
3. 89,675 × 98. 8,788,150. Ans.

Standard III.

A.

1. Add together £3,076 11s. 8½d. ; £47 12s. 9d. ; 9s. 11¾d. ; £9,001 0s. 5¾d. ; £8,640 18s. 10½d.
£20,766 13s. 9½d. Ans.

2. From £9,500 17s. 10½d. take £1480 18s. 9¾d.
£8,019 19s. 0¾d. Ans.

3. Divide six hundred and seventy one thousand and ninety four by 189.
$3{,}550\frac{144}{189}$. Ans.

4. A piano and a music stool cost together £17 10s. The price of the music stool was 38s. 6d., how much was that less than the price of the piano ?
£13 13s. 0d. Ans.

B.

1. Take £4750 18s. 4½d. from £5090 12s. 9d.
£339 14s. 4½d. Ans.

2. Divide four hundred and eighteen thousand and seventy by one hundred and seventy-six.
$2375\frac{70}{176}$. Ans.

3. Add £3,701 9s. 10½d. ; 18s. 11¾d. ; £435 9s. 2½d. ; £73,614 17s. 3¼d. ; £16 10s. 10d.
£77,769 6s. 2d. Ans.

4. Of 101 passengers by a ferry boat 75 persons paid one penny each and the remainder 2d., how much was paid altogether ?
6s. 3d. + 4s. 4d. = 10s. 7d. Ans.

STANDARD IV.

A.

1. Multiply £180 1s. 0½d. by 98.
£17,645 2s. 1d. Ans.

2. Divide £1,674 8s. 6½d. by 87.
£19 4s. $11\frac{9}{29}$d. $\frac{38}{87}$. Ans.

3. Reduce £533 14s. 0d. to florins.
5337 florins. Ans.

4. Reduce 18 fur. 16 poles 2 ft. 2 in. to inches.
145,754 inches. Ans.

B.

1. Divide £1,093 16s. 0d. by 93.
£11 15s. $2\frac{1}{2}$d. $\frac{18}{93}$. Ans.

2. Multiply £18 13s. $4\frac{3}{4}$d. by 918.
£17,138 17s. $4\frac{1}{4}$d. Ans.

3. How many pounds, shillings and pence are there in 3,414,400 farthings?
£3,556 13s. 4d. Ans.

4. Reduce 1,046 acres 1 rood 3 poles $16\frac{3}{4}$ yds. to yards.
5,063,957½ yards Ans.

STANDARD V.

A.

1. Find the cost of 36 barrels 29 galls. 1 pint at £36 18s. 9d. per barrel.
£1359 12s. 8d. Ans.

2. Add $\frac{3}{4}$, $\frac{1}{2}$, $\frac{5}{6}$ together, and take away $\frac{7}{8}$.
$1\frac{61}{120}$. Ans.

3. If 188 men do a piece of work in 36 days, how many will do it in 24 days?
282 men. Ans.

4. Make a bill for 3 oz. tea at $4\frac{3}{4}$d. per oz.; 7 pairs of cuffs at 1s. 3d. per pair; 12 yards of silk at 3s. 6d. per yard; 15 collars at 1s. 2d. per dozen; 9 yards of stuff at 3s. 4d. per yard.
(1s. $2\frac{1}{4}$d. + 8s. 9d. + £2 2s 0d. + 1s. 5½d + £1 10s. 0d.)
£4 3s. $4\frac{3}{4}$d. Ans.

B.

1. 974 cubic yards 6 feet 100 inches at £500 per cubic yard.
£487,112 3s. 7d. Ans.

2. $\frac{2}{5} + \frac{5}{6} + \frac{3}{4} - \frac{2}{3}$ $1\frac{13}{120}$. Ans.

3. A man bought a cargo of 270 tons of apples at £4 per ton, and sold them at 9d. per stone. What did he gain?
(Selling price = 9d. × 8 × 20 = £6 per ton. Gain = £2 per ton.)
£540. Ans.

4. If 3 cwt. cost £2 10s. 0d., what will 8 cwt. cost?
£6 13s. 4d. Ans.

STANDARD VI.

A.

1. $\dfrac{\frac{2}{5} + \frac{3}{4} - 1\frac{5}{12}}{\frac{3}{4} + 3\frac{1}{2} + \frac{5}{6}} \times \dfrac{5}{2 - \frac{3}{5}}$
$\frac{136}{170}$. Ans.

2. Find the cost of ·0625 miles of road at ·75 of £1 1s. 0d. per yard.
£86 12s. 6d. Ans.

3. After spending $\frac{3}{5}$ of what I had, I then lost $\frac{1}{3}$ of what remained, and I then had £1 15s. 0d. left. What had I at first?
£6 2s. 6d. Ans.

4. A can do a piece of work in 4 days, B in 6, and C in 8. In what time will they do it working together.
$1\frac{1}{13}$ days. Ans.

B.

1. Simplify $\dfrac{\frac{2}{3} - \frac{2}{5}}{\frac{3}{4} \text{ of } \frac{5}{6}} \div \dfrac{4\frac{1}{2} + 2\frac{1}{3}}{9 - \frac{4}{3}}$
$\frac{1412}{1845}$. Ans.

2. Add ·625 of 1s.; ·75 of 1s.; ·3125 of 1 crown; and ·0025 of £1.
(7½d. + 9d. + 1s. $6\frac{3}{4}$d. + $\frac{3}{5}$d.) =
2s. $11\frac{17}{20}$d. Ans.

3. A man's wages are £600; he spends £225 10s. 7½d. in 146 days; what would he save in 1 year, spending always at the same rate?
£36 3s. 5½d. Ans.

4. A man has $\frac{3}{7}$ of an estate; he sold $\frac{2}{5}$ of his share, and what he had left was divided among 3 boys and 4 girls, so that each boy gets twice as much as a girl. What share would a boy and girl each receive?
Boy, $\frac{7}{78}$; girl, $\frac{7}{156}$. Ans.

STANDARD VII.

BOYS.

1. If nine men can dig a trench 15 yds. long in 24 days, how many men would be required to dig a trench 60 yds. long in 64 days.

				men		men
yards	15	: 60	:: 9	:	$13\frac{1}{2}$.	Ans.
days	64	: 24				

2. If in a school of 175 boys, 43 are 7 years of age, 32 eight years old, 36 are 9 years of age, 24 are 10, 17 are 11, 11 are 12, and the remainder are 13 what is the average age of the children.
$9\frac{8}{175}$ years. Ans.

3. A farmer having 750 sheep sold 6 per cent. of them on Monday, 130 on Wednesday and 4 per cent. of the remainder on Saturday, how many sheep had he left?
552 sheep. Ans.

4. Two lots of tea were bought, one at £10 6s. 8d. per cwt., the other at £12 per cwt., at what price per lb. must the mixture be sold to gain £15 per cent.
2s. $3\frac{20}{23}$d. Ans.

GIRLS.

1. Find the number of miles a train would travel in 6 days of 11 hours each, if in 11 days of 9 hours it could go a distance of 4,284 miles.

				miles		miles
days	11	: 6	:: 4284	:	2,856.	Ans.
hrs.	9	: 11				

2. A grocer bought 5 lbs. of tea: for the first lb. he gave 2s. 8d., for the second 2s. 10d., for the third 4s., for the fourth 3s. 3d., and for the fifth 2s. find the average price per lb. at which the tea must be sold to gain 3s. 4d. on the whole.

18s. 1d. ÷ 5 = 3s. 7⅖d. Ans.

3. A gentleman's income was £756, of which he spent 80 per cent., how much money had he left?

£151 4s. 0d. Ans.

4. Find value of ⅛ of £1 17s. 6d. and ·368 of £2 17s. 6d. and bring the same to the fraction of £5.

·2116 or $\frac{529}{2500}$. Ans.

Physiology.

STAGE I.

A.

1. What is a ligament? Give the names and position of the principal ligaments of the body.
2. Name the bones of the upper arm, and show how they are connected with each other.
3. Write as much as you can about the brain and spinal cord.
4. Draw a skull, and show the position of the Frontal, Parietal, Temporal, and Occipital bones.
5. Name the chambers of the heart, and the blood-vessels leading *to* and *from* the heart.
6. Name a few of the largest bones of the body, and show their positions.

B.

1. What is muscle? Name some muscles, and say where they are.
2. Describe the ribs. What are their uses?
3. Write all you can about the flat and hollow bones.
4. Name the bones of the hand, and number the different kinds of bones.
5. Describe the stomach, liver, and kidneys, as well as you can.
6. How many teeth has a full grown person? Name the different kinds, and say how many there are of each kind. Draw a molar.

Music.

STAGE IV.

Time Exercise.

l. l : l	: l	l :—	—:
l :-. l	l : l. l	l :—	l :

Modulator Exercise.

d s_1 d m s d m r d ^{s}d t_1 l_1 s_1
d m d r d ^{d}s f r d s d.

Mental Arithmetic.

STANDARDS V. AND VI.

From 60 take away its half; ⅔ of remainder; ⅓ of this remainder; multiply by 5.

Add ¼ of £1 to ⅛ of £1, and take ⅛ of £1 away.

Add ⅔ and ⅞; ⅛ and ¼; ⅔ and ⅝; ½ and ¾.

Find cost of 24 at ¾d.; 27 at 1½d.; 43 at 7½d.; 13 at 1½d.; 24 at 2s. 1d.

If I had ½d., how much of a penny loaf would I receive?

If I paid £16 for 1 ton of steel, how much is that per cwt.?

240 articles at 8s. 6d. each.

Difference between ⅐ and ⅛.

Multiply ·4 by 6.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.
2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.
3. **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**
4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.
5. Replies will not be sent through the post.
6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher, Pilgrim Street, Ludgate Hill, London, E.C.*

General.

1. W. H. HARRIS.—Thanks for your solutions. You will notice that we have used them.

2. LEX.—It is a matter of taste. Dr. Smith's larger grammar is a most excellent one, but too full for you at present. Try *Goodwin's*. *Schmidt's* and *Farrar's* are also good.

3. D. JONES.—*Sweet's* 'Anglo-Saxon Primer' contains all you want. The Vulgate can be ordered through any bookseller.

4. DOUBTFUL.—It is not said. But most likely a definite number of marks are added on for two or more of them; do not study too many; you have not the time for it. You could use 'French Principia,' Part I., or *Macmillan's* 'Progressive French Course,' Parts I. and II., or many others.

5. JURISPRUDENCE.—Your first business is to get the books named and read them; order them through any bookseller. In Constitutional History use *Hallam's* and *May's*. You should consult the last two Calendars and see for yourself the sort of questions which are proposed. You may feel that you need definite direction and help. If so you could not do better than write to some of the gentlemen who advertise in the Calendar, and who would give you special information you might require. All the books named are dear.

6. FLOY.—Large hand bad in shape, with jagged strokes and incorrect curves, 60. Text hand, shapes incorrect, 55. Small hand is legible, which is a great merit, but it is nothing more, 50.

7. NIHIL SINE LABORE.—Writing very good, 80 for small, and 75 for large hand, which is a little too upright.

8. STUDIOUS.—There is no examination for the distinction known as F.R.G.S. The letters imply that the person who uses them is a member of the Royal Geographical Society. It is generally understood that he takes an interest in geographical matters, and knows something about them. You can obtain full information by writing to the secretary, Burlington House, Piccadilly, S.W.

9. J. W.—*Mackay's* 'Intermediate Geography' will suit your purpose very well. There are others that would do as well. For the music use *Dunstan's* 'Manual' (J. Hughes), *Landon's* 'School Management' (K. Paul) is very good. We know of no annotated edition of the essay you mention. It is easy and needs little explanation that you cannot make out for yourself.

10. JUMBO.—1. No. 2. Buy *Cowham's* 'Mulhaüser's Manual,' and you will see for yourself. A. Too thick, clumsy, 60. B. Much better, but is large hand written small, 75. C. and D. both too thick; capitals good; forms fair, 70.

11. WELSHMAN.—We cannot remember what your writing was last time. The small hand is now legible but too upright. You are imitating forms not yet officially recognised, 70. The text hand and large hand are better than the small hand, 75 and 80.

12. F.R.G.—Yes. The 'Student's Hume' (Murray), *Green's* 'History of the English People' (Macmillan), *Cox's* 'History of England' (Hughes).

13. ANXIOUS EX. P. T.—Use the book you name if you have not time to master a bigger one, and *Mackay's* 'Intermediate Geography.' Preferred by whom? If you wish to enter a college you should apply. Your admission depends upon many things—your health and character and ultimate aims, none of which are inquired into at the place you name. So far as your place on the list is concerned it does not matter where you sit. The writing is not uniform; some letters belong to one style, some to another. Both the large hand and the small hand may be much improved by a few minutes' practice a day. Get *Cowham's* 'Mulhaüser's Manual of Writing.'

14. DOUBTFUL.—The Code is really very explicit. You can get marks in the way it says, and in no other way. Read it again. The answers you refer to were not to the question you proposed.

15. ASSISTANT.—Consider a rectangle A B C D, of which the side A B is on the surface of the liquid. To find the centre of pressure of the liquid upon the rectangle is the same problem as finding the centre of gravity of the triangle ECD, where E is the middle point of A B. This is on the line joining E and F the middle point of C D at ⅓ the distance of E F. Now suppose a rectangle of twice the length of the former one; the centre of pressure on it will be at a distance of ⅔ of its base from the surface If we now construct a triangle having the base of the rectangle for its base, and the point E for its apex, and draw a line parallel to the base through the middle point of AC; we have then the centre of gravity of the whole triangle and that of the upper triangle given, and we have to find the centre of gravity of the lower trapezoid. If the side of the rectangle = 3 ft., the centre of gravity of the small triangle is 2 ft., and that of the larger 4 ft. from the surface, and that of the trapezoid is 3⅓ ft. from the surface.

16. CASTLE.—(1) Perhaps it would be better to prove that the point E will fall between D and C, but it can be demonstrated without using Prop. 47.

Thus:—$\angle$ DFC is greater than $\angle$ ADF, (I. 16.)
And $\angle$ ADF = $\angle$ ADB;
$\therefore$ $\angle$ ADB is greater than $\angle$ ACD,
$\therefore$ $\angle$ DFC is greater than DCF,
Wherefore DC is greater than DF. (I. 19.)
But DF = DB,
$\therefore$ DC is greater than DB,
That is, DC is greater than half BC.
Wherefore the point E (which is the point of bisection of BC) falls between D and C.

(2) We are gratified to hear that the query columns have been of service to you.

17. DUNELM.—
Let x = the number of grammes of copper, and
y = the number of grammes of iron sulphate.
Then $x + y = 632$ grammes
Also $\frac{96\,y}{278} + \frac{96x}{285{\cdot}5} = \frac{96 \times {\cdot}514}{233}$
This gives a value of y greater than that of the whole mixture, which shows that the sum sent us is not correct.

18. FORD.—Two bodies P and Q are connected by a fine thread passing over a perfectly smooth fixed horizontal cylinder; the mass of P is greater than that of Q; P is allowed to descend through a distance H, drawing up Q; at the instant the distance has been described, part of P falls off leaving only P′, the mass of which is less than that of Q; find how far P′ will descend. (*Mechanics, 1885.*)

Here P + Q is the mass put in motion by the excess of the force of gravity on P over that on Q, hence the force producing motion is Pg − Qg, and consequently $f(P + Q) = g(P - Q)$ or $f = g\frac{P - Q}{P + Q}$.

The velocity acquired in moving through distance h is found from the formula $V^2 = 2gs$, which in this case becomes $V^2 = 2hg\frac{P - Q}{P + Q}$. This is the velocity when part of the weight P falls off leaving only P′ which is less than Q.

The force of gravity is now $g\frac{Q - P'}{Q + P'}$ and tends to produce motion in the opposite direction. We have now to find how far a body with an initial velocity of v will travel against an accelerating force of f and that is given by the formula $V^2 = v^2 - 2fs$, by putting $V^2 = 0$, hence $V^2 = 2fs$ or $S = \frac{V^2}{2f}$.

In this case let the distance be h′

$$\text{Then } h' = \frac{\left(2hg\frac{P - Q}{P + Q}\right)^2}{2g\frac{Q - P}{Q + P'}}$$

$$= \frac{4h^2g^2\left(\frac{P - Q}{P + Q}\right)^2}{2g\frac{Q - P'}{Q + P'}}$$

$$= \frac{2h^2g(P - Q)^2(Q + P')}{(P + Q)^2(Q - P')}$$

19. J. BRIDGE.—A rectangular slab (specific gravity = 3), 1 inch thick, 10 inches long, 8 inches broad, is placed on a table, with one side (whose edge is parallel to the edge of the table) projecting beyond it. A weight of 1 lb. is placed on the opposite edge: how far can the slab be pushed off the table without falling? (*Browne's* 'Mechanics for Junior Students.')

Let D = distance in inches in addition to half the length of the slab;

Then, $\left(\frac{D \times 8 \times 1}{1728} \times 3 \times 1000\right)$ oz. = ¼ lb.
= 8 oz.

$$\frac{3000\,D}{1728} = 1$$
$$3000\,D = 1728$$
$$125\,D = 72$$
$$\therefore D = \tfrac{72}{125}.$$

$\therefore$ Slab can be pushed $5\frac{72}{125}$ inches off the table without falling.

20. C. KENT—Your writing fairly exemplifies nearly all the possible errors. Criticism is needless till you cease to begin to make the letter O on the left hand side of it. You will do exceedingly well also to attend to your composition. Per cent. is not a verb. The sum is worked thus:—

Let a, b, c, be the three sides; then (1) $a = \frac{b + c}{2}$
(2) $a + b + c = 84$ ft.
whence (1) $b + c = 2a$ and (2) $b + c = 84 - a$. $\therefore$ (sub.) $3a = 84$ ft.
and $a = 28$ ft.

By formula: 126 sq. ft. $= \sqrt{42(42 - 28)(42 - b)(42 - c)}$;
squaring we have $15{,}876 = 42(14)(42 - b)(42 - c)$ or $= 588\{1764 - 42(b + c) + bc\}$

$\therefore 27 = 1764 - \overline{42 \times 56} + bc$ or $= 1764 - 2352 + bc$
$\therefore 615 = bc$ and $56 = b + c$ whence $\underline{b = 41}$ and $\underline{c = 15}$.

Algebra.

1. J. MACKLAND AND MARK TWAIN.—Solve :—

$$(a)\ \frac{1}{x+a+b}=\frac{1}{x}+\frac{1}{a}+\frac{1}{b}.$$

$$(b)\ mx^2-\frac{m^2-n^2}{mn}x=1.$$

The following are simpler solutions of the above equations than those which appeared in our last issue :—

$$(a)\ \frac{1}{x+a+b}=\frac{1}{x}+\frac{1}{a}+\frac{1}{b}$$

$$\frac{1}{x+a+b}-\frac{1}{a}=\frac{1}{x}+\frac{1}{b}$$

$$\frac{a-x-a-b}{a(x+a+b)}=\frac{b+x}{bx}$$

$$-\frac{b+x}{a(x+a+b)}=\frac{b+x}{bx}$$

$$-\frac{1}{a(x+a+b)}=\frac{1}{bx}$$

$$-a(x+a+b)=bx$$

$$-ax-bx=a(a+b)$$

$$-(a+b)x=a(a+b)$$

$$\therefore x=-a.$$

As we divided each side by $b+x$, we can put $b+x=0$.

$$\therefore x=-b.$$

$$(b)\ mx^2-\frac{m^2-n^2}{mn}x=1$$

$$m^2nx^2-m^3x+n^2x=mn$$

$$m^2nx^2-m^3x=mn-n^2x$$

$$m^2x(nx-m)=n(m-nx)$$

$$=-n(nx-m)$$

$$m^2x=-n$$

$$\therefore x=-\frac{n}{m^2}.$$

As we divided each side by $(nx-m)$, we can put $nx-m=0$

$$nx=m$$

$$\therefore x=\frac{m}{n}.$$

2. R.B.—Solve :—

$$(x+\tfrac{1}{2})(x-\tfrac{1}{4})-(x+5)(x-3)+\tfrac{3}{4}=0.$$

(Todhunter.)

$$(x+\tfrac{1}{2})(x-\tfrac{1}{4})-(x+5)(x-3)+\tfrac{3}{4}=0$$

$$(x^2+x-\tfrac{1}{8})-(x^2+2x-15)+\tfrac{3}{4}=0$$

$$x^2+x-\tfrac{1}{8}-x^2-2x+15+\tfrac{3}{4}=0$$

$$x-2x-3+15=0$$

$$-x+12=0$$

$$-x=-12$$

$$\therefore x=12.$$

3. HOPEFUL.—Find the G. C. M. (by the ordinary method of dividing) of

$$3a^3-12a^2-a^2b+10ab-2b^2$$

and $6a^3-17a^2b+8ab^2-b^3$. *(Hamblin Smith.)*

The given expressions are not symmetrical, and the G. C. M. *cannot* be found by the ordinary method of division.

$$3a^3-12a^2-a^2b+10ab-2b^2$$

$$=3a^3-a^2b-12a^2-10ab-2b^2$$

$$=a^2(3a-b)-(12a^2-4ab)+(6ab-2b^2)$$

$$=a^2(3a-b)-4a(3a-b)+2b(3a-b)$$

$$=(3a-b)(a^2-4a+2b).$$

$3a-b)\ 6a^3-17a^2b+8ab^2-b^3\ (2a^2-5ab+b^2$

$6a^3-2a^2b$

$-15a^2b+8ab^2$

$-15a^2b+5ab^2$

$3ab^2-b^3$

$3ab^2-b^3$

$\therefore$ G. C. M. $=3a-b$.

4. LYCIDAS.—Solve :—

$$(a^2-x^2)^{\frac{1}{2}}+x(a^2-1)^{\frac{1}{2}}=a^2(1-x^2)^{\frac{1}{2}}.\quad \textit{(Bonnycastle.)}$$

$$(a^2-x^2)^{\frac{1}{2}}+x(a^2-1)^{\frac{1}{2}}=a^2(1-x^2)^{\frac{1}{2}}$$

$$x(a^2-1)^{\frac{1}{2}}=a^2(1-x^2)^{\frac{1}{2}}-(a^2-x^2)^{\frac{1}{2}}$$

$$x^2(a^2-1)=a^4(1-x^2)-2a^2\sqrt{(1-x^2)(a^2-x^2)}+(a^2-x^2)$$

$$a^2x^2-x^2=a^4-a^4x^2+a^2-x^2-2a^2\sqrt{(1-x^2)(a^2-x^2)}$$

$$2a^2\sqrt{(1-x^2)(a^2-x^2)}=a^4-a^4x^2-a^2x^2+a^2$$

$$2\sqrt{(1-x^2)(a^2-x^2)}=a^2-a^2x^2-x^2+1$$

$$=a^2(1-x^2)+(1-x^2)$$

$$=(a^2+1)(1-x^2)$$

$$4(1-x^2)(a^2-x^2)=(a^2+1)^2(1-x^2)^2$$

$$4(a^2-x^2)=(1-x^2)(a^2+1)^2$$

$$4a^2-4x^2=(a^2+1)^2-x^2(a^2+1)^2$$

$$x^2(a^2+1)^2-4x^2=(a^2+1)^2-4a^2$$

$$x^2(a^4+2a^2-3)=(a^2-1)^2$$

$$x^2=\frac{(a^2-1)^2}{a^4+2a^2-3}$$

$$\therefore x=\frac{a^2-1}{\pm(a^4+2a^2-3)^{\frac{1}{2}}}.$$

As we divided each side by $(1-x^2)$, we can put

$$1-x^2=0$$

$$x^2=1$$

$$\therefore x=\pm 1.$$

The value $x=-1$ satisfies the equation.

5. LYCIDAS.—Solve :—

$$\left.\begin{matrix}x^n+y^n=2a^n\\ xy=c^2\end{matrix}\right\}\quad \textit{(Bonnycastle.)}$$

$$\left.\begin{matrix}(1)\ x^n+y^n=2a^n\\ (2)\ \ xy=c^2\end{matrix}\right\}$$

From (2) $y=\frac{c^2}{x}$

$$\therefore y^n=\frac{c^{2n}}{x^n}$$

$$(1)\ x^n+\frac{c^{2n}}{x^n}=2a^n$$

$$x^{2n}+c^{2n}=2a^nx^n$$

$$x^{2n}-2a^nx^n=-c^{2n}$$

$$x^{2n}-2a^nx^n+(a^n)^2=a^{2n}-c^{2n}$$

$$x^n-a^n=\pm(a^{2n}-c^{2n})^{\frac{1}{2}}$$

$$x^n=a^n\pm(a^{2n}-c^{2n})^{\frac{1}{2}}$$

$$\therefore x=\left\{a^n\pm(a^{2n}-c^{2n})^{\frac{1}{2}}\right\}^{\frac{1}{n}}$$

$$\therefore y=\frac{c^2}{x}$$

$$=\frac{c^2}{\left\{a^n\pm(a^{2n}-c^{2n})^{\frac{1}{2}}\right\}^{\frac{1}{n}}}$$

6. LYCIDAS.—Solve :—

$$\frac{a^n}{x^n}+\frac{(a^{2n}-x^{2n})^{\frac{1}{2}}}{x^n}=\frac{x^n}{b^n}\quad \textit{(Bonnycastle.)}$$

$$\frac{a^n}{x^n}+\frac{(a^{2n}-x^{2n})^{\frac{1}{2}}}{x^n}=\frac{x^n}{b^n}$$

$$\frac{(a^{2n}-x^{2n})^{\frac{1}{2}}}{x^n}=\frac{x^n}{b^n}-\frac{a^n}{x^n}$$

$$\cdot b^n(a^{2n}-x^{2n})^{\frac{1}{2}}=x^{2n}-a^nb^n$$

$$b^{2n}(a^{2n}-x^{2n})=(x^{2n}-a^nb^n)^2$$

$$a^{2n}b^{2n}-b^{2n}x^{2n}=x^{4n}-2a^nb^nx^{2n}+a^{2n}b^{2n}$$

$$x^{4n}=2a^nb^nx^{2n}-b^{2n}x^{2n}$$

$$x^{2n}=b^n(2a^n-b^n)$$

$$\therefore x=b^{\frac{1}{2}}(2a^n-b^n)^{\frac{1}{2n}}.$$

Also, as we divided each side by x^{2n}, we can put

$$x^{2n}=0$$

$$\therefore x=0.$$

7. J. O. K.—Solve :—

$$(a+\sqrt{x})^{\frac{1}{3}}+(a-\sqrt{x})^{\frac{1}{3}}=b^{\frac{1}{3}}. \quad \textit{(Barnard Smith.)}$$

$$(a+\sqrt{x})^{\frac{1}{3}}+(a-\sqrt{x})^{\frac{1}{3}}=b^{\frac{1}{3}}$$

Cubing each side $\Big\}$ $(a+\sqrt{x})+3(a+\sqrt{x})^{\frac{2}{3}}(a-\sqrt{x})^{\frac{1}{3}}$

$$+3(a+\sqrt{x})^{\frac{1}{3}}(a-\sqrt{x})^{\frac{2}{3}}+(a-\sqrt{x})=b$$

$$3\left\{(a+\sqrt{x})^2(a-\sqrt{x})\right\}^{\frac{1}{3}}+3\left\{(a+\sqrt{x})(a-\sqrt{x})^2\right\}^{\frac{1}{3}}=b-2a$$

$$\left\{(a+\sqrt{x})(a+\sqrt{x})(a-\sqrt{x})\right\}^{\frac{1}{3}}+\left\{(a-\sqrt{x})(a+\sqrt{x})(a-\sqrt{x})\right\}^{\frac{1}{3}}=\frac{b-2a}{3}$$

$$\left\{(a+\sqrt{x})(a^2-x)\right\}^{\frac{1}{3}}+\left\{(a-\sqrt{x})(a^2-x)\right\}^{\frac{1}{3}}=\frac{b-2a}{3}$$

$$(a^2-x)^{\frac{1}{3}}\left\{(a+\sqrt{x})^{\frac{1}{3}}+(a-\sqrt{x})^{\frac{1}{3}}\right\}=\frac{b-2a}{3}$$

$$(a+\sqrt{x})^{\frac{1}{3}}+(a-\sqrt{x})^{\frac{1}{3}}=\frac{b-2a}{3(a^2-x)^{\frac{1}{3}}};$$

But, $(a+\sqrt{x})^{\frac{1}{3}}+(a-\sqrt{x})^{\frac{1}{3}}=b^{\frac{1}{3}}$

$$\therefore b^{\frac{1}{3}}=\frac{b-2a}{3(a^2-x)^{\frac{1}{3}}}$$

Cubing each side $\Big\}$ $$b=\frac{b^3-6ab^2+12a^2b-8a^3}{27(a^2-x)}$$

$$27b(a^2-x)=b^3-6ab^2+12a^2b-8a^3$$

$$-27bx=b^3-6ab^2+12a^2b-8a^3-27a^2b$$

$$=b^3-6ab^2-15a^2b-8a^3$$

$$\therefore x=\frac{8a^3+15a^2b+6ab^2-b^3}{27b}.$$

8. MARK TWAIN.—Solve :—

$$x+\sqrt{a^2+x^2}=\frac{na^2}{\sqrt{a^2+x^2}}. \quad \textit{(Colenso.)}$$

$$x+\sqrt{a^2+x^2}=\frac{na^2}{\sqrt{a^2+x^2}}$$

$$x=\frac{na^2}{\sqrt{a^2+x^2}}-\sqrt{a^2+x^2}$$

Squaring each side $\Big\}$ $$x^2=\frac{n^2a^4}{a^2+x^2}-2na^2+(a^2+x^2)$$

$$2na^2-a^2=\frac{n^2a^4}{a^2+x^2}$$

$$2n-1=\frac{n^2a^2}{a^2+x^2}$$

$$(2n-1)x^2+(2n-1)a^2=n^2a^2$$

$$(2n-1)x^2=n^2a^2-(2n-1)a^2$$

$$=(n^2-2n+1)a^2$$

$$x^2=\frac{a^2(n-1)^2}{2n-1}$$

$$\therefore x=\frac{a(n-1)}{\pm\sqrt{2n-1}}.$$

NOTE.—It will be found that the value which satisfies the equation is :—

$$x=-\frac{a(n-1)}{\sqrt{2n-1}}$$

Mensuration.

1. SCHOLARSHIP.—Find the side of a triangle (equilateral) equal in area to a square whose side is 10 feet.

Area of equilateral triangle
= square of side × ·433...;

$\therefore$ Side^2 × ·433 = (10 ft.)^2
= 100 sq. ft.
Side^2 = 100 sq. ft. ÷ ·433
= ·433) 100·0 (230·9468
866
1340
1299
4100
3897
2030
1732
2980
2598
3820
3464
356
= 230·9468... sq. ft.
$\therefore$ Side = $\sqrt{230\cdot9468}$ sq. ft.
= 230·9468 (15·1969
225
301 | 594
301
3029 | 29368
27261
30386 | 210700
182316
303929 | 2838400
2735361
103039
= 15·1969... ft. Ans.

Or :—

Side^2 × ·433 = (10 ft.)^2
Side × $\sqrt{\cdot433}$ = 10 ft.
$\therefore$ Side = 10 ft. ÷ $\sqrt{\cdot433}$
= 10 ft. ÷ ·658...
= ·658) 10·00 (15·197
658
3420
3290
1300
658
6420
5922
4980
4606
374
= 15·197... ft. Ans.

2. W. W. S.—Find the diagonal of a square that shall be equal in area to a rectangle of which two adjacent sides are 30 and 20. (*Moffatt's* 'Pupil Teachers' Year Book.')

Diagonal^2 = 2 Side^2
= Twice Area
= 2 (30 × 20)
= 1200
$\therefore$ Diagonal = $\sqrt{1200}$
= 1200 (34·64
9
64 | 300
256
686 | 4400
4116
6024 | 28400
27696
704
= 34·64... Ans.

Arithmetic.

1. Folkestonian.—A and B start at the same time from two points 27 miles apart, A going at the rate of 3 miles every 55 minutes, and B 2¼ miles in 38 minutes. When and where will they meet?

$$\left.\begin{aligned} \text{A's rate per minute} &= \tfrac{3}{55} \text{ mile} \\ \text{B's} \quad \text{,,} \quad \text{,,} &= \tfrac{2\frac{1}{4}}{38} \text{ ,,} \\ &= \tfrac{9}{152} \text{ ,,} \end{aligned}\right\}$$

$$\left.\begin{aligned} \therefore \text{A's rate} : \text{B's rate} &:: \tfrac{3}{55} : \tfrac{9}{152} \\ &:: 228 : 275 \end{aligned}\right\}$$

$\therefore$ Distance travelled by A when they meet

$$= \frac{228}{228 + 275} \text{ of } 27 \text{ miles}$$

$$= \frac{228 \times 27}{503} \text{ miles}$$

$$= \tfrac{6156}{503} \text{ miles}$$

$$= \underline{12\tfrac{120}{503} \text{ miles.}} \quad \text{Ans.}$$

$$\text{Time} = (\tfrac{6156}{503} \div \tfrac{3}{55}) \text{ min.}$$

$$= \frac{2052 \times 55}{503} \text{ min.}$$

$$= 224\tfrac{332}{503} \text{ min.}$$

$$= \underline{3 \text{ hrs. } 44\tfrac{332}{503} \text{ min.}} \quad \text{Ans.}$$

—o—

The 'Practical Teacher' Sale and Exchange Column.

Owing to numerous requests, we have been induced to start this Exchange Column for the benefit of our readers. We shall be glad to insert announcements relating to the 'Sale or Exchange' of books, etc., at the rate of One Penny per line, *prepaid.*

What offers for 36 parts of Cassell's Popular Educator, new issue, complete, and in good condition? Address, H. Hoades, 46, Albert Street, Newark, Notts.

For Sale.—Vols. I., II., III., IV. and V. of Practical Teacher, unbound. Will be sent securely packed for half-price (15s.), buyer paying carriage. Also 'Currie's Principles and Practice of Common School Education,' 2s.—Address, 'Master,' National School, Ivington, Leominster.

For Sale.—Goldsmith's History, 1s. 3d.; (Mrs. Fawcett) 'Political Economy,' 1s. 6d.; (Jevons) 'Primer of Political Economy,' 9d.; (Dick) 'Outlines of Political Economy,' 9d.; 'British Colonies' (Faunthorpe), 1s.; 'Practical Hints on Class Management' (James Saunders), 1s. 6d.; Treatise on Logarithms and Key to ditto, 9d.; Primer—Physiology, 2d.; Cornwell's Geography, 1s.—Address, C. Childs, Chatsworth-road, Brampton, Chesterfield.

Wanted.—Strongly bound books for school and village library.—Master, Schoolhouse, Capel, Dorking.

For Sale.—Colenso's Algebra (4s. 6d.), 2s.; Keith Johnston's Geography (6s.), 2s. 9d.; Mason's Grammar (2s.), 10d., *postage included.* All in good condition. Also, Cassell's Euclid (1s. 6d.), 6d., and many others. Send for list.—T. George, 1, Vine-villas, Victoria-road, Snaresbrook, E.

Mr. Wills, 80, Chorley Old-road, Bolton, will be glad to hear of any person having Certificate and Scholarship Syllabuses, previous to 1880, for Sale. Clean copies only. Also reprints of the above or Pupil Teachers' Examinations of any date.

For Sale.—Arithmetics, Hamblin Smith (3s. 6d.), 2s. 6d.; Elsee's (3s. 6d.), 2s. 6d.; Cornwell and Fitche's (4s. 6d.), 2s. 10d.; Colenso's (4s. 6d.), 2s. 6d.; Wrigley's Examples and Problems in Pure and Mixed Mathematics (8s. 6d.), 4s.; Jones and Cheyne's Algebraical Exercises, 2s.; Cowper's Poems, strongly bound, in two volumes, 1s. 6d.; Dr. Ahn's First French Course, 9d.; Hughes' Physical Geography, 1s. 3d.; Second Grade Geometry Book for Students, by Thomas Andrew, 1s. The prices in brackets indicate the published price. All the above are in excellent condition and post free.—Address Mr. James C. Johns, St. Peter's-terrace, Flushing, near Falmouth.

Publications Reviewed.

The Student's Handbook of Historical Geology. By A. J. Jukes-Browne, B.A., F.G.S. London: George Bell and Sons.

This treatise on Palæontological and Historical Geology admirably finishes the author's scheme for supplying the student of Geology with a complete text-book.

The material at the author's disposal has swollen to great dimensions, and the difficulty of selection has correspondingly increased. No one, however, who carefully studies these chapters can fail to be struck with the wide area of research, with the sound judgment in the selection and arrangement of the matter, and with the value of the inferences which are deduced. The science of Geology owes very much indeed to the wide and profound knowledge which in the work before us is abundantly displayed, at the same time the student of Geology will be delighted to find in its pages the facts and theories of his science clearly stated and abundantly as well as admirably illustrated. The most modern matter has been laid under tribute, at the same time theories which are highly speculative have been carefully avoided.

Amongst the illustrations—all of which are excellently drawn—the vertical sections are very numerous and to the ordinary student they are new.

The former volume devoted to Physical and Structural Geology has been adopted in classes under the most enlightened direction, and much anxiety has been manifested by students for the appearance of the present work. We have no hesitation in stating that the Historical Geology fulfils our highest expectations and that we anticipate for it a most favourable reception by all students of the science.

The Eclogues of Calpurnius Siculus and M. Aurelius Olympius Nemesianus. By Ch. H. Keene. Bell and Sons.

If the publication of such valuable editions as we have here will persuade the Oxford and Cambridge Local Examination Syndicate to enlarge their field of choice of subjects to be prepared, how the teachers throughout the country will thank their Authors.

Though no doubt no scholar can read a book of Virgil, even for the hundredth time, without finding some beauty, which he has passed unnoticed before, still, it would be a great relief to many to have new ground to plod over, as every really painstaking teacher must plod in preparing his candidates for examination.

The introduction is exceptionally full, and treats in the most scholarly and interesting way of the probable date of the poem; of the genuineness of the last four eclogues, which the author assigns, and with good reason, to Nemesian rather than Calpurnius; of the different MSS. and editions; concluding with a short essay on Idyllic Poetry, which is worthy the notice of those reading works of a similar nature.

Underneath the text in each page we have first the notes of a critical nature, as to readings, &c., and beneath them in double column those as to meaning and grammar.

These notes are of the most thorough kind, giving, without doubt, all the information a student ought to have so near at hand; in fact we can almost imagine some teachers objecting to so much being obtainable so easily.

This is not the first work of Mr. Keene's, his edition of the 13th Book of Ovid's 'Metamorphosis' having been thoroughly welcomed by scholar and critic alike.

At the conclusion of the volume there is an interesting Appendix on the 7th Eclogue, as to what amphitheatre is therein described; and this is followed by a copious index.

We trust the work, as it deserves, may receive a hearty welcome in the literary and scholastic world, and so popularise these little known Latin authors.

Shakespeare's 'Coriolanus,' with Notes, &c. W. and R. Chambers.

The publishers do not tell us whom we are to thank for this useful edition of this fine old play.

The little volume consists of an introduction which gives us the source of Shakespeare's knowledge of the story, with a few remarks thereon, concluding with three valuable quotations from Coleridge, Schlegel, and Hallam respectively, on the impartiality of Shakespeare's politics; on his power of seizing on the poetical point of every historical transaction; and on the fitness of the character of Coriolanus, as we read it, for Shakespeare to build up his magnificent creation thereon.

The play itself occupies some 90 pages, and this is followed by nearly 30 pages of notes, which contain much more than this number would indicate, since the print is very small, though clear. These notes are just what a boy or girl wants, explaining the obsolete terms, giving the historical and mythological allusions, as well as discussing etymological questions, with frequent references to Abbott's invaluable grammar and other standard works.

At the beginning of the book there is a single page, which is of such importance that it figures on the title page, being called a 'Plan of Study for Perfect Possession.' We should like, had we room, and if it were fair to do so, to quote this page in full, so useful do we deem it.

Few teachers even, and scarcely any students, know how to set about gaining a perfect knowledge of a work written in their own language.

This page alone ought to sell the book, so well and thoroughly is it done.

In other respects the volume is all that we expect it to be, coming as it does from the great Scotch house, being well printed, strongly bound, and wonderfully cheap.

Types of Nations. (Wall Plates.) London: W. and A. K. Johnston.

This series is well worthy attention; and the care that has evidently been taken to delineate not only the national types themselves but also the many little accessory details typical of the national life, will cause these plates to meet with cordial appreciation. Judging from the consular reports that have lately been commented upon in our daily journals in connection with trade depression, not a little of the present commercial crisis is due to the comparative ignorance, on the part of our manufacturers, of foreign nations and their needs. We have supplied flannels and clothing of hideous design and vivid colouring to that artistic race the Japanese, in whom an almost æsthetic appreciation of delicate tints and forms is innate. We seem to have sent ploughs and other implements of the most orthodox British patterns to Turkey, South America, and other places where special makes were almost imperatively needed, and in fact we appear to have displayed all round either great ignorance of foreign requirements or great carelessness in adapting our manufactures to our customers' wants. The correction of this ignorance or carelessness is one of the surest ways to increase our waning foreign trade; and diagrams such as those now under our consideration are one of the many ways through which our young folks—the British traders of the future—may obtain lasting and truthful information respecting the folks 'beyond the seas.'

The Lay of Horatius. By Lord Macaulay. Blackie and Son.

The notes of this edition, which are full and to the point, are printed at the bottom of each page. The poem being composed in modern times, there is no scope for etymological discussion, without going into the subject far more than would be possible in a work of this nature, we are not therefore surprised to find that the explanations are almost entirely with regard to the places and individuals named in the poem, the one exception which we noticed being the derivation of the old word 'trysting.'

Vere Foster's Copy Books: Bold Writing Series. In 17 numbers. London: Blackie and Son.

Most teachers are familiar with the earlier series of Vere Foster's copy books, and the fine, light, graceful, current-hand which they exhibit. This new series begins with large hand, in ¾-inch ruling, which was carefully, and we think on good grounds, excluded from the former series, and which is here introduced simply to meet the wishes of those school inspectors and teachers who still think that the largest hand-writing should be the first taught. The various books lead up gradually to a bold Civil Service hand in the last two numbers. If there were any teachers who considered the writing in the earlier series too light and fine, it is quite possible that the opposite fault may be found with the new series. The strokes both up and down are considerably thicker, the letters are more round and upright, and the loops shorter and more open. The result is that while the writing gains a little in legibility it loses decidedly in gracefulness, and presents a rather heavy black appearance. Which of the two styles is preferable is, in the main, a question of taste; but we are inclined to prefer to either a style between the two.

Natural History Wall Plates. London: W. and A. K. Johnston.

The two samples before us of this series represent respectively the Common Fox and the Chimpanzee; and taking these as standards we have no hesitation in saying the plates have our approval as being well adapted for the purpose in view. In design they are vigorous and artistic, and being effectively coloured and strongly mounted, they are well calculated to give satisfaction in all respects.

The drawing of the chimpanzee errs perhaps a little in giving too flattering a portrait of the creature. We confess however that our acquaintance with this particular anthropoid is of a comparatively slight nature, being based chiefly on pictorial representations and the 'pickled remains' at the South Kensington Natural History Museum. These remains are ugly enough in all conscience, and a careful study of the enormous and grotesquely horrid heads, with their frightful side developments, grinning from the glass vessels in which they are preserved, is enough to give a nightmare to any but the most confirmed lover of natural history. Perhaps therefore in consideration of the feelings of the little folks for whose benefit these plates have been designed, the artist has taken a very advisable course in toning down the more specially repulsive points of his subject.

Object Lesson Pictures for Schools. London: A. Johnston.

There are few lessons more attractive to young people than object lessons; and there are few things of more assistance to the teacher in the delivery of such lessons than bright and interesting diagrams. The four wall plates now before us are strongly mounted on stout cardboard; and seem well adapted in every way for school use. These are carefully drawn, and attractively coloured; and their varnished surfaces will prove a great protection against dust and dirt.

The subjects dealt with are:—(1) a lifeboat, (2) a fire engine, (3) a railway station, and (4) a post office; and a few lines will suffice to give a fair idea of the manner in which each has been treated.

In the first-named the time of day is probably early morning as the lighthouse on the distant headland is represented as still sending its rays seawards, the sky is black and murky,—only broken by the lightning flash,—and the lifeboat, one of the standard type of the National Lifeboat Institution, is being pulled manfully by its cork-jacketed crew through some tremendous breakers towards a shipwreck shown in the distance.

The steam fire-engine represented in the second plate is one of the usual metropolitan type; and the house on fire, the fire-escape, and the other details of the drawing afford plenty of illustrative matter for lessons on the work of the fire brigade. The plate of the railway station is equally representative, and is complete even to the reproduction of three or four advertisement posters of somebody's soap and other well advertised wares. The post office plate satisfactorily illustrates the working of our postal system, and the little additional inset views draw special attention to the various sections, dealing respectively with the newspaper, inland letter, foreign letter, and parcel-post departments. It may be added that on the back of each plate is given a full description of the subject illustrated: the necessity for private research on the part of the teacher being thereby to a great extent obviated.

A Primary History of Britain. Edited by William Smith, D.C.L., LL.D. Murray.

A work of this kind, covering, in only 420 pages, such a period as 'from the earliest times to the fall of Lord Beaconsfield's Ministry in 1880,' must be very terse in its style.

We are assured in the original preface that it is free from political and sectarian bias, and we are bound to say that, in comparing the Marian and Elizabethan religious persecutions, we think the writer or editor may fairly lay claim to the statement.

The paragraphs of each chapter are numbered, and headed or commenced with a few words in thicker type to note the nature of the matter discussed or related; and the year of the period is printed on every page.

The work concludes with some genealogical tables, and an index.

Without mentioning the price, we can assure our readers that it is a very valuable volume for the money.

(1.) Matriculation Guide.

(2.) Intermediate Mathematics.

(3.) B. A Mathematics.

London: Baillière, Tindall and Cox.

These are three little books intended to give students direction in their preparation for graduation in the London University:—

(1.) The Matriculation Guide contains sixteen pages of general directions chiefly as to books. The remaining twenty pages contain the examination papers set in January 1887, together with the solution of the questions set in Mathematics. Students will find some useful advice in these pages. Altogether it is a cheap shilling's worth.

(2.) The Intermediate Mathematics is a larger book, giving more complete directions as to the text books to be used and course of study followed in preparing for this part of the intermediate examination. Those who are obliged to study without assistance will find a good deal of help in this book. They need not slavishly follow its directions but they cannot fail to obtain many useful hints. The test papers are specially useful. They consist very largely of questions set in past examinations and have therefore been made by able men and are specially suited to the capacities of students who are hoping to pass this examination.

(3.) The B.A. Mathematics contains the questions, and solutions of them, which have been set from 1881 to 1886. There is a short introduction containing a few directions, but the bulk of the book (36 pages) is taken up with the questions and solutions. Where the solution is a mere piece of book work, references are given to ordinary manuals, where the student will find the special point discussed. We can recommend this little volume to all whom it may concern.

Early Greek Reader. By Evelyn Abbott, M.A. LL.D. Clarendon Press.

This little volume of 80 pages being another addition to the Clarendon Press Series, we should not have expected to have to make any remark on the printing, &c., but in this instance the fine bold type is so marked a feature of the work that we cannot refrain from alluding to it.

Why small children, who have only just learnt to read, should be expected to be able to read the intensely small type that we often find in their hands, with which to learn their hymns, we never could understand. Mr. Abbott, however, evidently knows that the eye is an immense help to the mind, and that to be able to see clearly a word with its marks is almost half the battle, especially with a new character.

The first part of the Reader consists of tiny little stories, of from 4 to 6 or 7 lines long, collected under the significant title of 'The Wisdom of Fools.'

After this we have some of Æsop's Fables, of which in several instances we have more than one version, which is done to make the difficulty of the vocabulary as light as possible.

The last set of stories, taken from the life of Æsop, are longer and perhaps more interesting.

On the title page we see the word 'Text,' which we presume implies that a second volume containing some notes, and we hope a vocabulary, is eventually to be published.

The Greek found in these stories is not quite that of Demosthenes and Xenophon, being written at a date subsequent to them, but the author—and holding so important a post as tutor of Balliol, the most classical College at Oxford, he is surely entitled to all respect for his opinions—thinks that the 'defect is perhaps compensated (for the learner) by the more modern cast of the thoughts.'

Questions to Longmans' Geography. By George G. Chisholm, M.A., B.Sc. London: Longmans, Green and Co.

The capital school book on modern geography, upon which these questions are based, has already been favourably reviewed in these columns (vol. vi., page 331), and we are glad to be able to speak in equally laudatory terms of the publication now before us. Mr. Chisholm possesses a wide and well-sifted store of geographical knowledge, and has displayed in the framing and scope of his questions an originality which is as satisfactory and interesting as it is rare. As stated in the preface, his aim has been to suggest questions of a kind fitted to develop the thinking powers of the pupils, and hence has confined himself for the most part to such questions as involve a comparison of different parts of the text book. He has fulfilled his task in a highly creditable manner, and the book abounds with questions which might well be taken as models for examinational work. The teacher must be remarkably well posted in geographical lore who does not find on every page some points requiring 'looking up,' and some questions suggesting interesting side-light views on the subject matter involved. We may add that, for the assistance of those using the question-book, references are copiously made to those pages of the manual from which the required information may be collected.

Conspectus of Indispensable Rules and Exceptions for Preliminary Examinations in French. By Chetwode Crawley, LL.D., &c. London: Longmans and Co.

A small publication with a long title, to which, however, it quite corresponds. It consists of a printed sheet folded into a cardboard cover, and when opened shows the rules for forming plurals and feminines of substantives, feminines and plurals of adjectives, and adverbs from adjectives, and on the reverse side the chief irregular verbs, and rules for the formation of tenses. The lists of exceptions are very full.

Longmans' New Geographical Readers. The Sixth Reader for Standard VI. London: Longmans, Green, and Co.

Having recently noticed the Fifth Reader of this series at some length, we need say little more than that the new number exhibits the same excellent features, and fully maintains the high character of the series. The book relates to Asia, Africa, and America, and includes lessons specially treating of Climate and the Interchange of Productions. Summaries of the geography of the most important countries are printed opposite the respective maps of the same, and a general summary is placed at the end with folding maps of the three continents on vegetable vellum. The clear print, glossy paper, and well-executed illustrations, combine to make the volume very attractive. We are pleased to see that books III. to VI. of the series have been adopted by the London School Board.

Longmans' Handbooks of Geography. Books III. to VI. for Standards III. to VI. London: Longmans, Green, and Co.

The summaries of geography contained in the same publishers' New Geographical Readers having been reprinted, are here presented in company with maps full enough to show all the places named, and yet not, as a rule, at all overcrowded. The matter is so arranged that the map and the text relating to it can almost invariably be seen at the same opening of the book, and without turning the book round to look from the text to the map. In Book III. many excellent divisional maps of England are inserted, and the printing of the names is very clear. In all the books, facts relating to industry have a prominent place. At the end of Numbers III. and IV. are found lists of names of places with accents. Each number is firmly stitched in a limp linen cover. The whole series is admirably adapted for memory or home lessons as companions to Longmans', or almost any series of Geographical readers.

Goldhanger Woods, A Child's Romance. By M. and C. Lee. National Society's Depository.

This is a very pretty story of a child, who being supposed to be the great aunt of the narrator, is naturally found amongst people who lived in the old days, before gas and vaccination had come into use, and when smuggling was rife.

We are at first introduced to a family of children, who are almost immediately taken down into the country to be inoculated for small pox, and whilst there the heroine of the story gets mixed up with the interesting trials and mistakes of an unfortunate girl and her brother, who have lost their mother, and are cursed with a wicked old father.

The tone of the book is so thoroughly good that it is not only likely to interest, but to instruct and enoble, and as such we heartily recommend it as a most welcome prize to any girl of twelve, or even a little older.

There are two full paged pictures, but the volume would, in our eyes, be just as well without them.

Owing to pressure on our space we are compelled to hold over How to teach the Babies, and a number of Queries and Reviews.

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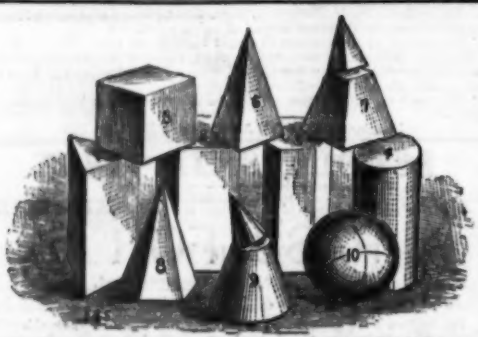

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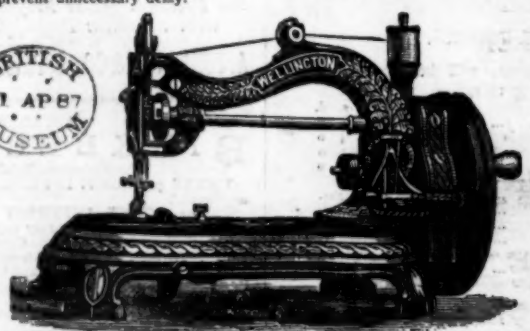

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